The Journal of ELECTRICITY POWER and GAS

DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

VOL. XIV.—No. 4 SAN FRANCISCO, CAL., APRIL, 1904. YEARLY SUBSCRIPTION - $2.00 SINGLE COPIES - 25 CENTS

1889 PARIS EXPOSITION MEDAL FOR RUBBER INSULATION

OKONITE TRADE MARK.

1893 WORLD'S FAIR MEDAL FOR RUBBER INSULATION

SOLE MANUFACTURERS OF

OKONITE WIRE

THE STANDARD FOR RUBBER INSULATION

OKONITE TAPE : MANSON TAPE

CANDEE WEATHER-PROOF WIRE

CANDEE (PATENTED) POTHEADS

THE OKONITE COMPANY, Ltd.,

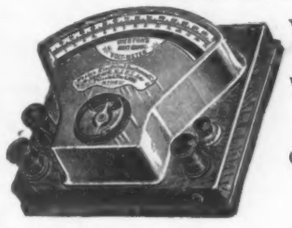
Willard L. Candee, H. Durant Cheever } Managers
Geo. T. Manson, General Superintendent
W. H. Hodgins, Secretary

253 Broadway NEW YORK

WESTON Electrical Instrument Co.

Waverly Park, NEWARK, N. J., U. S. A.

New York Office: 74 Cortlandt Street



Weston Standard Portable Direct Reading

VOLTMETERS, MILLIVOLTMETERS, VOLTAMMETERS, AMMETERS, MILAMMETERS, GROUND DETECTORS AND CIRCUIT TESTERS, OHMMETERS, PORTABLE GALVANOMETERS.

Our Portable Instruments are recognized as the STANDARD the world over. The SEMI-PORTABLE LABORATORY STANDARDS are still better. Our STATION VOLTMETERS and AMMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.

BERLIN: European Weston Electrical Instrument Co., Ritterstrasse, 88.
LONDON: Elliott Bros., Century Works, Lewisham
PARIS, FRANCE: E. H. Cadiot, 12 Rue St. Georges

Constant Meese, President *F. Gottfried, Vice-President*
Walter N. Kelly, Secretary

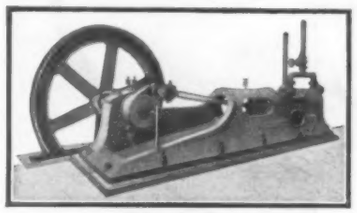
Meese & Gottfried Company.

ENGINEERS AND MACHINISTS

Nº 167 TO 179 FREMONT STREET.
TELEPHONE EXCHANGE 487

SPECIALTY.
POWER TRANSMITTING MACHINERY AND ALL PERTAINING THERETO.
AGENTS FOR LINK BELT MACHINERY CO., CHICAGO.

SAN FRANCISCO.



VULCAN ICE MACHINES

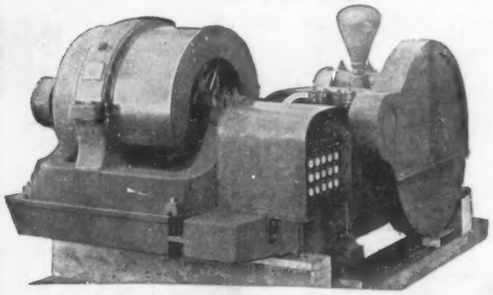
Plate Process Ice-Making Plants

For Making Clear Ice With Electric Power

VULCAN IRON WORKS

505 Mission Street SAN FRANCISCO

The General Electric Company's



Triplex Portable Pump Driven by 10-Horsepower General Electric Motor

Electric Pumps

can be readily shifted to any part of the mine without expense or delay and can be controlled by an operator placed in the most advantageous position

General Office: Schenectady, N. Y.

San Francisco Office, Crossley Building. Portland Office, Worcester Building. Denver Office, Kittredge Building. Los Angeles Office, Douglas Building.
Salt Lake City Office, 25 East First South Street.

INDEX TO CONTENTS PAGE XVIII. ADVERTISERS' INDEX PAGE VI.

174

Northern Motors

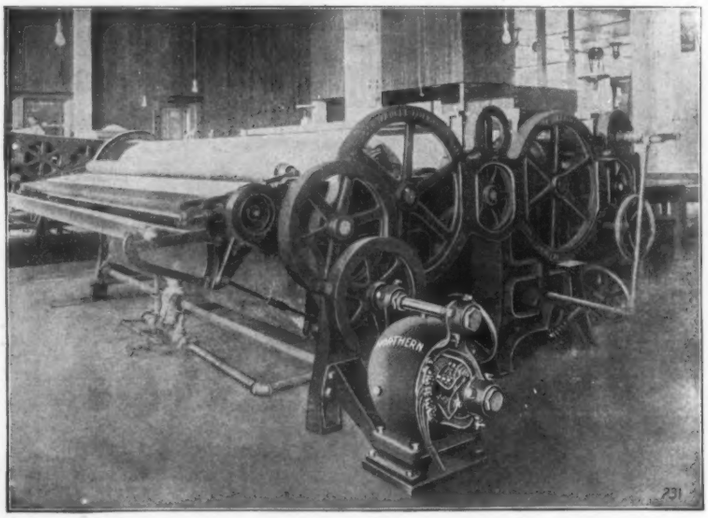
In Varied Industries

Affording constant economical operation in a wide range of successful American industries—potent factors of success.

The Simplicity and Compactness of Northern Apparatus is widening the field of electric transmission.

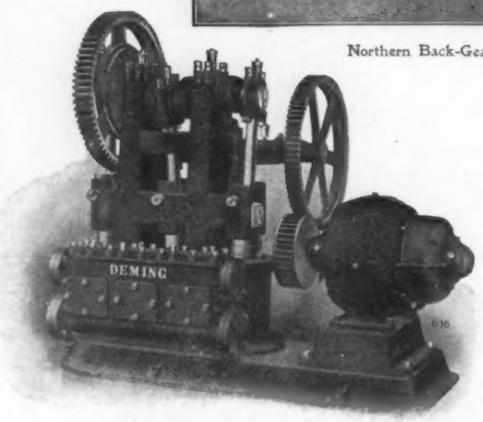
Northern Spherical Motor Operating Printing Press

Northern Motors Fit Their Work



Northern Back-Geared Motor Operating Hagen Mangle

Northern Motors Built in a Comprehensive Range of Types



Northern Spherical Motor Operating Deming Triplex Pump

Northern Apparatus

is economical in operation, simple, sturdy, compact, trustworthy and endowed with numerous features of convenience, excellence and merit

BULLETIN NO. 935

ENGINEERS—MANUFACTURERS

NORTHERN ELECTRICAL MFG. CO.

MADISON, WIS., U.S.A.

PACIFIC COAST OFFICES

69-75 New Montgomery Street, San Francisco, Cal.

507 Pioneer Building, Seattle, Wash. 521 Douglas Building, Los Angeles, Cal.

The Journal of Electricity, Power and Gas.

Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XIV. SAN FRANCISCO, CAL., APRIL, 1904. NUMBER 4

Report of Competitive Tests Between Babcock & Wilcox and Stirling Boilers Made at Los Angeles, Cal., 1903.

Pacific Light and Power Company, Los Angeles, Cal., A. C. Balch, Manager.
The Babcock & Wilcox Co., New York, Chas. C. Moore, Manager Pacific Coast Office.
The Stirling Company, Chicago, Edgar Kidwell, Pacific Coast Manager.

GENTLEMEN: In conformity with the articles of agreement, dated October 7, 1903, between the above named companies, relative to the making of certain tests upon Babcock & Wilcox Boilers and Stirling Boilers in the power plant of the Pacific Light and Power Company, a copy of this agreement being attached hereto, the undersigned committe herewith presents the following report:

Each of the parties to the above mentioned agreement transmitted to the committee in charge of the tests at its first meeting in San Francisco, on October 22, 1903, a written statement defining the scope the tests were to cover, copies of which statements are attached hereto.

After consideration of these statements, the committee formulated the following outline regarding the details of the tests to be made:

1. Four tests are to be made of each boiler. The first to be at a rate of evaporation per square foot of heating surface of 3½ to 4 pounds of water per hour, from and at 212 degrees Fahrenheit. The second test to be at a rate of evaporation of 4½ pounds per square foot of heating surface. The third test to be at a rate of evaporation of 5¾ pounds per square foot of heating surface. The fourth test to be the maximum capacity possible to be obtained from the boiler. The efficiency is to be determined in all tests made. The order of making the tests is to be determined later.

2. All tests are to be of ten hours duration.

3. The quality of steam is to be determined by means of a throttling calorimeter of the Barrus type; the correction for radiation to be made by closing the stop valve and calibrating the instrument on the assumption that the steam in the boiler, in a quiescent state, contains no moisture. The sampling nipple is to be inserted in the vertical steam pipe from the boiler, this nipple to be made of ½-inch pipe perforated with not less than twenty holes, each hole ⅛-inch in diameter, these holes extending around and along the pipe. The perforations are to begin at a point distant 25 per cent. of the inside diameter of the steam pipe from one side of the same, and are to extend to within the same distance of the other side, at which point the sampling nipple shall end and be closed by a plug or weld, as per sketch on Plate I.

4. The engineers representing the Stirling Company and the Babcock & Wilcox Co. are each to have the privilege of using the oil burner he may find best suited for use with his boiler and furnace, it being preferred that the same burner or type of burner be used in the tests of both boilers.

5. The steam used by the burners in atomizing the oil is to be measured by means of an orifice inserted in the steam pipe leading to the burners, with pressure gauges on each side for determining the pressure conditions of the steam passing the orifice, these conditions to be duplicated after the tests and the steam passed to a condenser and weighed. The amount of steam so determined is to be reported in pounds per hour for each test, and also as a percentage of the output of the boiler based on the equivalent hourly evaporation from 212 degrees Fahrenheit at the average steam pressure during the test.

6. The feed water is to be used as taken from the city mains.

7. Oil samples are to be collected during the tests by taking a small quantity from the oil pipe supplying the weighing barrel during each time of filling the same, the aggregate sample so taken to be divided into four parts, one part to be given to each member of the committee and the fourth part to be sealed and sent to a reputable engineer or chemist for calorimeter test of heating value and determination of percentage of water, the calorimeter used to be preferably of the Mahler bomb type.

8. During the test each engineer is to direct the handling of his boiler, burners, feed pump and other apparatus, it being understood that the conditions existing at the beginning of each test shall be duplicated at its completion, and these conditions are to be maintained as nearly uniform throughout the entire test as possible.

9. Flue gas analyses may be made at the option of the engineer in charge of the test.

10. The temperature of the feed water is to be taken at a point in the feed pipe near its connection to the boiler.

11. Every precaution is to be taken to insure accurate results; the feed water and fuel oil are each to be weighed on platform scales.

12. The apparatus used is to be compared with standards, and if found in error proper corrections made. It is also desirable that a test gauge be used for measuring the steam pressure, the same gauge to be used by each boiler and tested before connecting to the boiler. The weighing scales are to be tested by comparison with United States standard weights, and proper corrections made if necessary.

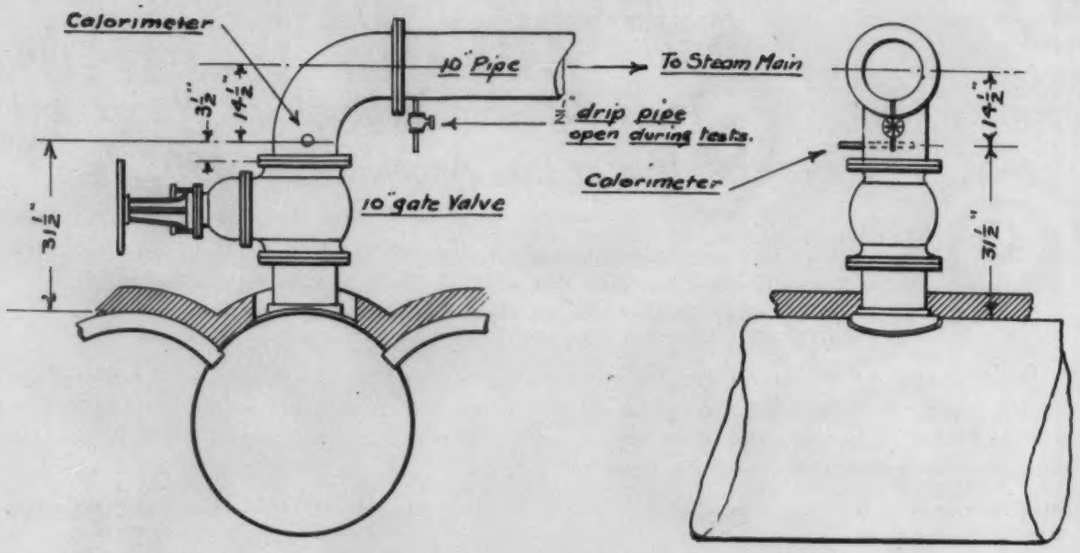
13. Preliminary tests are to be made by each representative of the boiler companies to enable him to make whatever changes he deems desirable, it being understood that every effort is to be put forth so that the official tests may be made as soon as possible. After beginning the official tests no further preliminary tests are to be made, and during each official test each member of the committee is to be continuously present.

14. The heating surface of each boiler is to be determined by the committee, and a statement thereof is to be included in the final report.

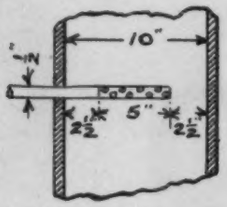
On November 24th the committee met at the plant of the Pacific Light and Power Company, in Los Angeles, and began the work preparatory to making the official tests. The outline indicated in the preliminary agreement was adhered to in practically every point.

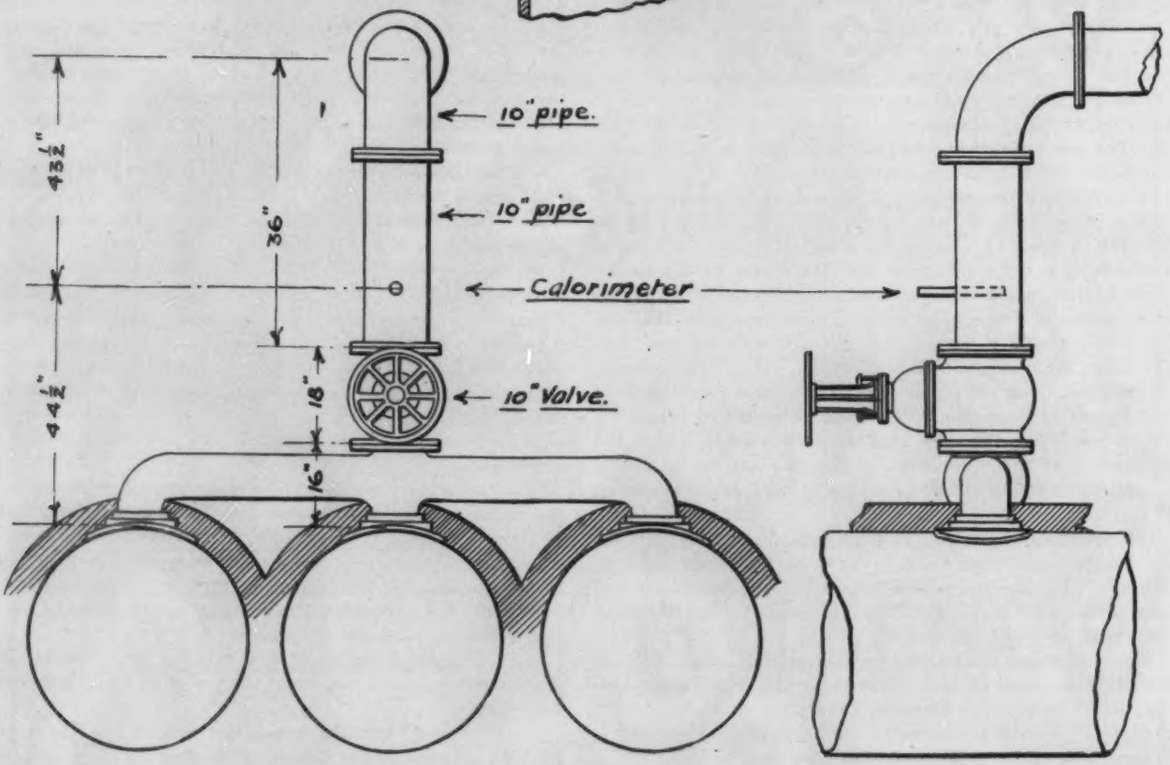
LOCATION CALORIMETER
STIRLING BOILER.

PLATE I.



SAMPLING NIPPLE
USED ON BOTH BOILERS.





LOCATION CALORIMETER
B. & W. BOILER.

ORDER OF TESTS.

The committee decided to make the tests in the following order:

First test—Babcock & Wilcox boiler, rate of evaporation 3½ to 4 pounds.

Second test—Stirling boiler, rate of evaporation 3½ to 4 pounds.

Third test—Stirling boiler, rate of evaporation 4½ pounds.

Fourth test—Babcock & Wilcox boiler, rate of evaporation 4½ pounds.

Fifth test—Babcock & Wilcox boiler, rate of evaporation 5¼ pounds.

Sixth test—Stirling boiler, rate of evaporation 5¼ pounds.

Seventh test—Stirling boiler, test for maximum capacity.

Eighth test—Babcock & Wilcox boiler, test for maximum capacity.

The relative order of making the first two tests was decided by lot, and the choice falling to the representative of the Stirling Company he decided to make the second test. It having been previously agreed that the first test of each pair of comparative tests at the same rate of evaporation should be made on each boiler alternately, the first, fourth, fifth and eighth tests were made on the Babcock & Wilcox boiler, and the second, third, sixth and seventh tests on the Stirling boiler.

CALORIMETER.

The same calorimeter was used on both boilers throughout the tests. It was of the Barrus throttling type, having an orifice ⅛-inch in diameter, and during the tests and also during the calibrations the same thermometers were used in the same relative position. The sample of steam was taken from the vertical steam pipe at a point as shown in the sketches on Plate I, through a perforated sampling nipple, constructed as above indicated.

OIL BURNER.

As set forth in Article 4 above, the engineers representing the respective boiler companies were to select the oil burner which each found best suited for use with his boiler and furnace. The engineer of the Babcock & Wilcox Co. selected the H. & M. burner for the tests made on the Babcock & Wilcox boiler. The engineer of the Stirling Company, after having experimented with the same type of burner used in the tests of the Babcock & Wilcox boiler, selected for the tests made upon the Stirling boiler the Hammel burner, the inventor of which, Chas. Hammel, operated the burners during all tests made upon the Stirling boiler.

APPARATUS FOR HANDLING AND WEIGHING FEED WATER.

The feed water was taken from the city mains and weighed in an iron tank on platform scales standardized by the committee both before and after the tests. The weighing tank was especially constructed for the purpose, having a capacity of about 2000 pounds, and was provided with a 3-inch outlet, equipped with a quick opening gate valve, through which the water, after being weighed, was discharged into a lower tank of about 3000 pounds capacity. An independent duplex feed pump 6 inches by 4 inches by 6 inches pumped the water from this tank and delivered it to the boilers through an independent feed line installed for the purpose of the tests. This independent line was so arranged that the feed water could be delivered to either boiler. The possibility of the feed water being delivered to any other point than the boiler under test was prevented by means of a double system of valves, one situated on either side of a free outlet. The same system was used for preventing water from any other source entering the boiler being tested. In addition, the blow-off connections were broken, as were also the drips from the water columns. It was made certain by this means that no leakage existed either to or from the boiler being tested, while at the same time the feed water system could be changed from one boiler to another in a few moments. When either of the boilers were under steam, but not being tested, feed water was delivered from the usual source of supply.

APPARATUS FOR HANDLING AND WEIGHING FUEL OIL.

Before beginning the official tests a storage tank of 6500 gallons capacity was installed near the boiler room and a supply of oil sufficient to make two tests, one on each boiler, was pumped into this tank. It was then sealed by the committee until after the completion of two comparative tests at the same rate of evaporation. The tank was again filled with oil, sealed, and two more tests completed, and so on until the final capacity tests, at which time, the capacity of the tank not being sufficient for both tests, an additional supply was put into the tank after the capacity test on the Stirling boiler had been completed and before the corresponding test on the Babcock & Wilcox boiler was begun.

The oil was taken from this storage tank by a pump, which was run continuously during the time of each test. This pump delivered the oil to a weighing barrel, as required, or returned it to the storage tank when the valve used for filling the oil barrel was closed. In this manner a thorough circulation and mixing of the oil in the storage tank was maintained throughout each test. A heater was also installed, by means of which the oil could be heated to the temperature desired by the engineer representing the boiler being tested.

After being weighed on platform scales standardized by the committee, the oil was delivered by gravity to a half barrel, from which it was taken by a duplex pump 3 inches by 2 inches by 3 inches, and delivered to the burners, an air chamber, pressure gauge and by-pass being located between the pump and burners for regulating the pressure of the oil. The by-pass allowed the oil to return to the half barrel, from which the suction of the pump was taken, and by opening or closing the valve on this by-pass any desired pressure could be maintained.

The delivery line to the burners was amply provided with valves and unions, so that the oil could be delivered to the burners under either the Babcock & Wilcox or the Stirling boilers at will, while at the same time the burners under each of the boilers could be operated from the regular oil supply of the plant when not under test. The oil supply during the time of the test was, however, entirely independent and separate from the regular supply of the plant.

As the oil flowed into the weighing barrel at each filling, a small sample was collected and placed in a closed can. The weighing barrel being filled frequently during the test, the sample thus collected represented the average quality of the oil used during the test. This sample was thoroughly mixed on the completion of the test and divided into four parts, each of which was sealed and disposed of according to the outline indicated above.

HEAT VALUE OF OIL.

Professor W. C. Blasdale, of the Department of Chemistry of the University of California, was selected by the committee to make the calorimeter tests of the samples of fuel oil. A copy of his report is attached hereto, from which the following summary is taken, the heat units per pound of oil corrected for moisture being calculated by the committee:

No. of fuel oil sample.	Date.	Boiler tested.	B. T. U's per pound of oil as received.	Per cent. of moisture.	B. T. U's per pound of oil corrected for moisture.
115	Dec. 4	Babcock & Wilcox.	18,428.4	1.06	18,626
118	" 5	Stirling	18,478.8	1.06	18,677
129	" 7	Stirling.....	17,791.2	4.93	18,714
120	" 8	Babcock & Wilcox.	17,887.5	4 62	18,754
113	" 16	Babcock & Wilcox.	16,904.7	8.71	18,518
116	" 17	Stirling.....	16,956	8.82	18,596
119	" 19	Stirling.....	18,567	.74	18,705
114	" 21	Babcock & Wilcox.	18,578.7	.42	18,657

CALIBRATION OF PRESSURE GAUGES AND THERMOMETERS.

The regular steam gauges were removed from both boilers, compared with a standard test gauge from the laboratories of the University of California, and adjustment made for the range of pressures covered during the test. The gauges were then replaced on the boilers, and after the tests were completed were again removed, and upon comparison with the standard test gauge found to be correct.

The pressure gauges used for measuring the pressure of the oil and the steam supplied to the burners were also compared with the standard test gauge before the tests were begun, and the necessary adjustments made. These gauges were also found to be correct after the completion of the tests.

All thermometers used were compared before the beginning and after the completion of the tests. The thermometers used in the calorimeter and for taking the temperature of the feed water were also tested with standards, and proper corrections made in working up the results.

STIRLING BOILER.

The Stirling boiler selected by the engineer of the Stirling Company for the tests, was put under steam in August, 1902, and is known as boiler No. 7 in the plant of the Pacific Light and Power Company. It is of the regular Stirling design, known as class "K," and consists of three upper, or steam, drums, known as front, middle and rear drums, and one lower, or mud, drum. All drums are horizontal, and connected by tubes which are bent to allow them to enter the drums normal to their periphery. These tubes are arranged in three banks, which are known as front, middle and rear, each leading from their respective drums to the lower or mud drum. The front and middle drum are connected by two rows of tubes, the upper known as steam and the lower as water circulating tubes, the middle and rear drum being connected with one row of tubes only, known as rear steam circulating tubes. The steam drums are each 42 inches in diameter by 11 feet 9¾ inches long, and extend through the boiler wall on one side only, the boiler being designed as a half battery. The lower, or mud, drum is 42 inches in diameter and 10 feet 3¾ inches long. All tubes are 3¼ inches in diameter. Each bank contains seventy-two tubes, arranged in four rows of eighteen tubes each, the length varying from 13 feet 8 inches to 17 feet 6 inches, depending upon location.

The steam is taken from the top of the middle drum in which is located a 6-inch dry pipe perforated with ½-inch holes. The feed water is delivered to the boiler through the top of the rear drum by a 2½-inch pipe, which has a tee on the lower end, from which there are two branch pipes extending lengthwise of the drums. This pipe has four openings, each opening being equipped with a spray plate. There is no other apparatus of any kind in any of the drums except that above mentioned.

The gauge or water glass is 14 inches in length and is connected to the middle drum near its top and bottom, the center of this gauge glass being 5 inches below the center line of the middle drum and 5½ inches above the center line of the front and rear drums.

The furnace is of the standard Stirling design, containing a fire brick arch extending from the front furnace wall. The distance measured perpendicularly from the front row of tubes to the face of this arch during the first two tests was 24 inches. Before the third and fourth tests were made, however, upon this boiler, a portion of the face of the arch was burned away, and after being trimmed up evenly, the above distance was increased to 28 inches.

The back half of the grates was covered solid, and all air for the oil burners taken through the front half of the grate. A loose brick wall was built across the ash pit to drive the air upward through the grates. A new checker work of fire brick nine courses high was built on the bridge wall in front of the front bank of tubes. The furnace was equipped with two Hammel burners, introduced in the usual manner through the fire doors.

Previous to the beginning of the official test a careful examination of the boiler was made with the object of ascertaining if any alteration or change should occur as a result of the tests. The tubes in the first row of the front bank were examined and note taken of a few slight blisters or burns found on the tubes for the purpose of comparison after the tests were completed. The boiler was also examined under pressure and found to be without leaks.

On November 25th the boiler was closed up and put in service as required in the plant until the first test, made on December 5th, the tubes having previously been cleaned internally with a turbine cleaner, the soot brushed off the external surfaces, and the air leaks through the setting closed, the entire boiler being put in good condition.

It was found that the draft in the flue leading from the Stirling boiler was insufficient for the tests at the higher ratings, and to overcome this condition it was decided by the committee to insert a feather plate in the flue and also to introduce a steam jet blower for the purpose of increasing the draft.

BABCOCK & WILCOX BOILER.

The Babcock & Wilcox boiler selected by the engineer of the Babcock & Wilcox Co. for the test was put under steam in August, 1903, and is known as boiler No. 9 in the plant of the Pacific Light and Power Company. It consists of three longitudinal drums, each 42 inches in diameter and 21 feet 3 inches in length, placed above and connected to a set of twenty-one sections of tubes, each section consisting of twelve tubes 4 inches in diameter and 16 feet in length. The tubes of each section are expanded in the front and rear into forged steel headers of serpentine form.

During the tests the openings between the front headers were closed with asbestos, as was also the space between each of the front nipples. Between the rear circulating tubes baffle bricks were placed, leaving an opening above this baffle of 33 inches. The lower ends of the sections are connected to the mud drum, which is 12 feet 4 inches in length and 12 inches in diameter. The sections are connected to the drums in front by nipples, and in the rear by circulating tubes expanded into cross boxes, which are riveted to the drums, there being seven sections connected to each cross box.

The feed water enters each drum through a straight open ended 2-inch pipe, no spraying devices being used. The water column is located on the front head of the left hand drum, the glass being 10 inches in length, the center of the glass corresponding to the center line of the drums. Steam is taken from the three drums through perforated dry pipes 6 inches in diameter and 7 feet in length. A cross pipe connects the steam outlet from each of the drums, and this in turn is connected to the vertical steam pipe leading to the steam main. A baffle plate is located over the front nipples in each of the drums.

The furnace is of the standard Babcock & Wilcox design for burning oil fuel, the burners, three in number, of the type known as the H. & M. oil burner, being installed through the lower front doors and extending to the rear of the furnace, where the tips are located, so that the flame is thrown forward into the combustion chamber. Air is admitted under the flame through openings between fire brick laid on the grate bars. No checker wall is used in this furnace.

Before the tests were begun the tubes in the lower row over the furnaces were examined and note taken of a few slight blisters or burns found thereon, a similar examination being made after the tests were completed. On November 21st the boiler was closed up and put in service as required in the plant, it having previously been cleaned internally and externally, using a turbine cleaner for the tubes and a brush for removing the soot from the external surfaces. The heating surface was measured on November 27th, at which time the two lower rows of tubes were again cleaned internally and a portion of the external surfaces brushed off. The boiler was tested under pressure and found to be without leaks, after which it was again put in service until the first test was made on December 4th.

HEATING SURFACE AND BUILDER'S RATING.

The heating surface of the boilers was measured by the committee, and as thus measured was used in determining the rate of evaporation at which each boiler should be operated during the first six tests of the series.

The heating surface of the Stirling boiler as measured by the committee is tabulated below:

216 long tubes, 17 water circulating tubes and 18 steam circulating tubes	2991.50	square	feet
Front drum	52.69	"	"
Middle drum	79	"	"
Rear drum	71.04	"	"
Lower, or mud, drum	93.54	"	"
	3287.77	square	feet

The heating surface of this boiler as determined by the committee is, therefore, 3288 square feet. As installed by the builders the heating surface was given as 3347 square feet, or 59 square feet more than the heating surface as determined by the committee.

The heating surface of the Babcock & Wilcox boiler was measured by the committee and is tabulated below:

252 long tubes	4211.55	square	feet
Headers, inside faces, front and rear	66.85	"	"
Inside half of front nipples	7.35	"	"
21 circulating tubes	110.25	"	"
3 drums	358.07	"	"
Mud drum, portion exposed in last passage	20.55	"	"
	4774.62	square	feet

As determined by the committee the heating surface of this boiler is, therefore, 4775 square feet. As installed by the builders the heating surface was given as 4669.5 square feet, or 105.5 square feet less than the heating surface as determined by the committee.

In determining the aggregate heating surface of both boilers, the external surfaces of the drums and tubes above the water line exposed to the hot gases was included.

The committee is aware that in its measurements of the heating surface of each of the boilers it has not followed the practice of either of the boiler companies, but the same method was followed by the committee in measuring the heating surface of both boilers.

The builders rating on each of the boilers tested is on the basis of 10 square feet of heating surface per horsepower, this heating surface being as given by the builders. The committee's rating in horsepower has likewise been determined on the basis of 10 square feet of heating surface per horsepower, this heating surface being as measured by the committee. The builder's rating of the Stirling boiler is, therefore, 335 horsepower, while the committee's rating is 329 horsepower. On the same basis the builder's rating of the Babcock & Wilcox boiler is 467 horsepower, while the committee's rating is 477 horsepower.

TESTS.

It was decided by the committee to start and stop the tests with the fires out in order to avoid errors due to a possible difference in the furnace conditions. Three minutes before the beginning of each test, therefore, the water level in the glass was noted, the oil shut off from the burners and the ash pit doors and dampers closed. The test was started with the boiler in this condition, the water level being again noted and officially recorded as the starting level, the fires having been out for a period of three minutes. The fires were then immediately lighted and the test proceeded until three minutes before the finish, when the fires were again put out, the level of the water in the glass taken, the latter being officially recorded as the water level for the end of the test. These water levels as taken by the committee for each test are given in the table of data and results.

The proper corrections due to difference in water level were subsequently determined by pumping weighed water at a temperature of 61 degrees Fahrenheit into the boilers when cold and noting the amount of water in pounds corresponding to a definite rise in level in the glass. The weight of this water was corrected for increase in temperature when the boiler was under steam.

The engineers representing the Babcock & Wilcox Co. and the Stirling Company each appointed three observers, two of whom, one representing each company, were detailed to weigh the feed water, two others to weigh the fuel oil and sample the same, and the two remaining to take the general log. The latter consisted of half hourly observations of the steam pressure, water level in the gauge glass, calorimeter readings, temperature of the feed water, oil, air in the fire room and the escaping gases, the pressure of the steam passing the orifice in the steam pipe leading to the burners, the draft pressure and the character of the smoke, if any, issuing from the stack. In the two tests for maximum capacity the water level and calorimeter readings were taken at fifteen minute intervals. Frequent observations were made personally by the third member of the committee for the purpose of checking the data and records of the six observers. The temperature of the escaping gases was determined with gas filled mercury thermometers reading to 800 degrees Fahrenheit. In the tests of each boiler these were placed in the top of the horizontal flue leading to the stack, as shown in Plate II.

Readings were also taken on a thermometer placed in the vertical neck of the flue of the Stirling boiler. In the first two tests this thermometer was found to indicate a temperature 40 to 50 degrees higher than the thermometer in the horizontal flue. In the last two tests at the higher rating the reading of the two thermometers indicated more nearly the same temperature, the difference being not more than 12 degrees Fahrenheit. The recorded temperatures of the escaping gases in the tests of the Stirling boiler were taken from the thermometer in the horizontal flue for the reason that the neck of the flue from the Babcock & Wilcox boiler was horizontal instead of vertical.

The smoke observations were taken for the purpose of comparison only, and were not referred to standard charts. No smoke was produced in any of the first four tests of the series, while in the fifth and sixth tests it amounted to only a trace. Some smoke was produced in the capacity tests, but at no time was this excessive. Other boilers, as shown in Plate III, were connected with the same stack as the boiler under test, and occasionally produced heavy smoke. Considerable care was therefore necessary in making these observations.

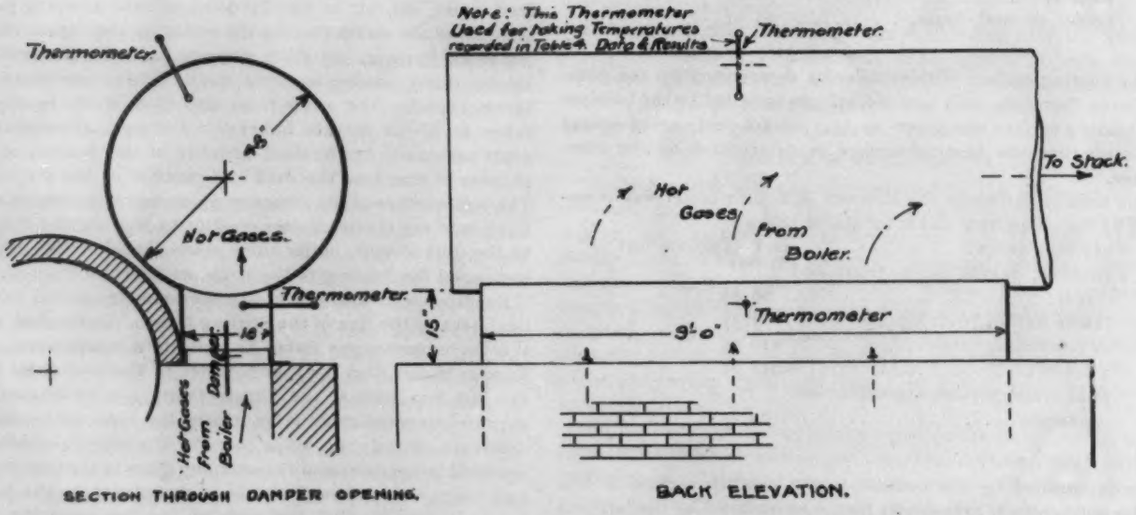
During the tests observations were made by the committee of the distribution of the flame in the furnace of the Babcock & Wilcox boiler through peep holes provided for the purpose. The flame was found to be evenly distributed over the tubes exposed in the first pass of the boiler above the furnace. Similar observations of the furnace of the Stirling boiler were made only from the front, the space above the arch alone being visible. In this space the distribution of the flame was uniform.

The first two tests on each boiler were made according to the program given above, and the data and results obtained are given in the accompanying table, together with those of the succeeding tests.

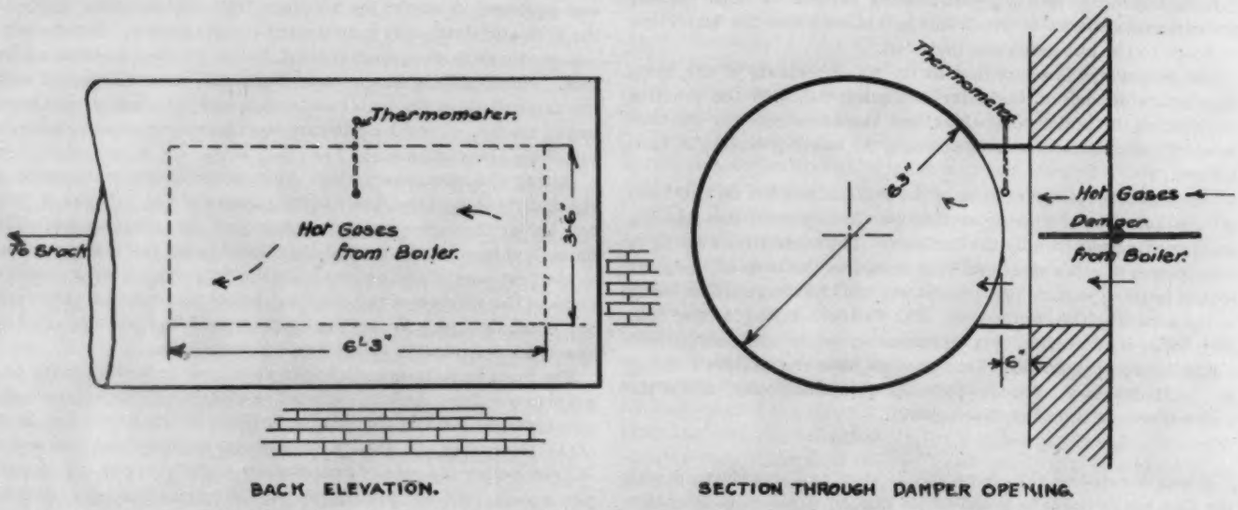
On December 9th the third test was made on the Babcock & Wilcox boiler at a rate of evaporation slightly above 5¾ pounds per square foot of heating surface from and at 212 degrees Fahrenheit, and the third test on the Stirling boiler had been run for four hours on December 10th when a leak was discovered in the bottom row of tubes of the Babcock & Wilcox boiler. As there could be no assurance that this had not existed during the test made on the previous day, it was decided by the committee to postpone the test of the Stirling boiler and to repeat the test on the Babcock & Wilcox boiler after again filling the oil storage tank, thus ensuring the use of the same quality of fuel oil for the two comparative tests.

On the following day, December 11th, the committee made a careful inspection of the Babcock & Wilcox boiler, it having been fired and kept in service on the evening of the 10th. It was

PLATE II

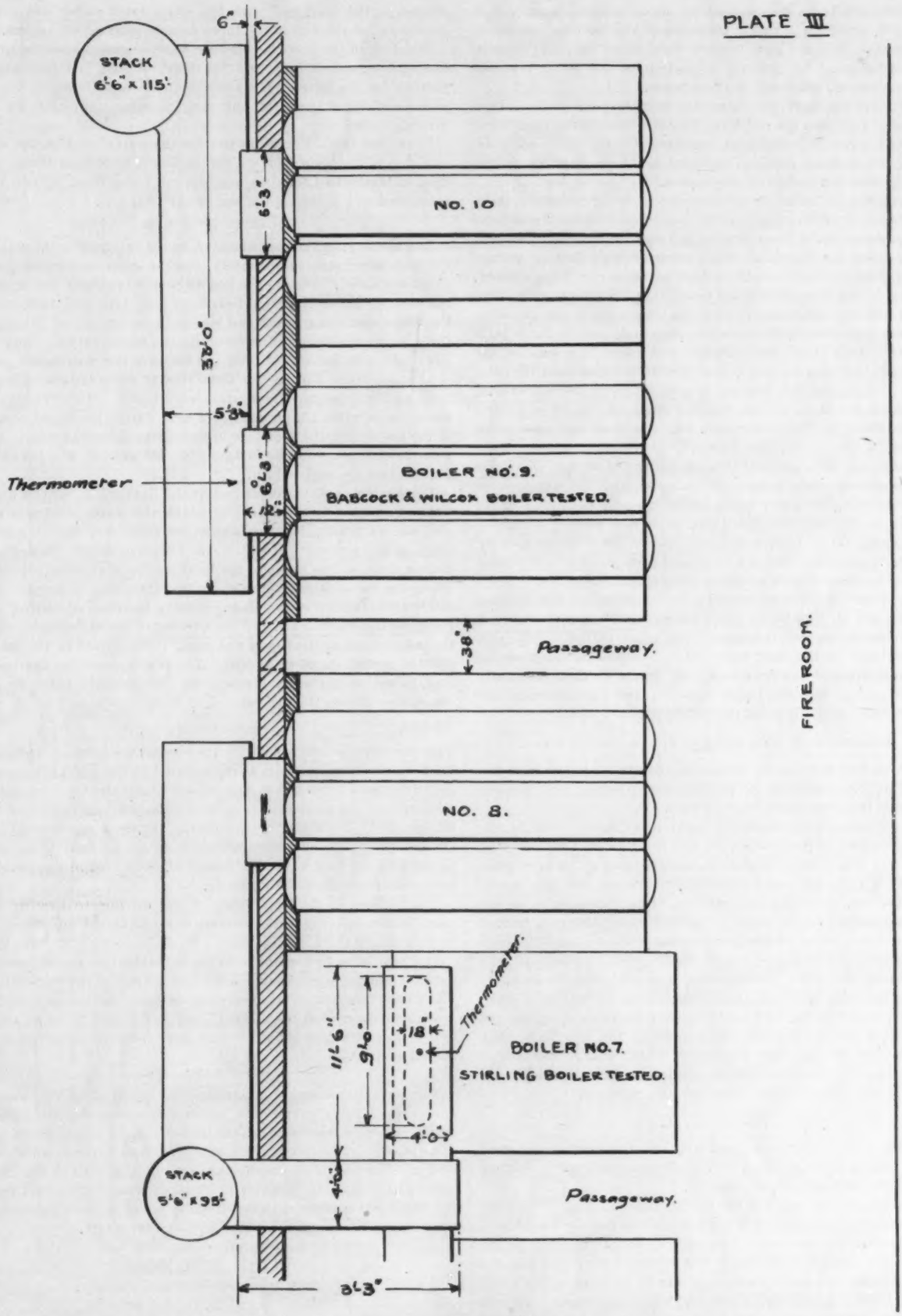


LOCATION OF FLUE GAS THERMOMETER - STIRLING BOILER.



LOCATION OF FLUE GAS THERMOMETER - BABCOCK & WILCOX BOILER.

PLATE III



LOCATION OF BOILERS IN PLANT
PLAN VIEW.

found that the leaks were caused by small cracks about ¼-inch in length, one each in two of the tubes of the bottom row above the furnace, and six new blisters were noted on other tubes of the bottom row. An internal inspection of the boiler revealed the presence of loose scale in these tubes.

The boiler was again put in service over the peak of the load of December 11th, and the following day new tubes were inserted in place of the two defective ones, together with an additional tube, which, although not leaking, was removed by the Babcock & Wilcox engineer as a matter of precaution.

In cleaning the boiler preparatory to beginning the official tests, the Babcock & Wilcox engineer had not cleaned the inside surfaces of the headers or the front nipples and rear circulating tubes, this surface being considered of minor importance as heating surface and the time the boiler could be kept out of service being limited. Finding during the preliminary tests that the changes of the feed water from city water used during the tests without compound to the water from the condenser with compound, used in the regular operation of the plant, had a tendency to loosen the scale in the headers and circulating tubes, he requested permission of the committee to wash out the bottom row of tubes on December 6th. This was objected to by the Stirling engineer, whose objection was sustained by the committee. At the time the new tubes were put in the boiler, the Babcock & Wilcox engineer again requested that he be allowed to wash out the tubes and clean the internal surface of the headers of his boiler, and this was done on December 13th, the boiler being closed up and examined under pressure on the 14th, and again put in service on the afternoon of that date. This boiler was again opened previous to making the last, or capacity, test, the two lower rows and the circulating tubes being cleaned with a turbine cleaner.

As the same privilege of cleaning was accorded to the Stirling engineer, the Stirling boiler was cleaned on December 15th. A turbine cleaner was put through all the tubes of the front bank and also those of the rear bank. The external surfaces of the tubes were brushed free from soot, the drums cleaned internally and externally, and the boiler closed up and put in service, the last two tests being made on December 17th and 19th.

CONDITION OF THE BOILERS AFTER THE TESTS.

After all the tests were completed, the two boilers were examined by the committee for the purpose of noting any changes which had taken place during the tests.

In the Stirling boiler marks of slight leaks were found at the expanded joints of seven tubes of the front bank and the mud drum, only one of which, however, showed any leak under pressure. This was small and not sufficient to necessitate the repetition of the test, the boiler the same day, without change, being put in regular service in the plant. Ten additional blisters or burned spots were also found on the tubes of the front row, one of which was located opposite an opening in the fire brick checker wall, the others being above the furnace about on a level with the arch.

In the Babcock & Wilcox boiler there were no marks of leaks at the expanded joints, and the tubes were found to be unchanged and without additional blisters as a result of the two tests made on December 16th and 21st, the first of which was at the rate of evaporation of 5.86 pounds per square foot of heating surface per hour, the last being the test for maximum capacity.

WATER LEVEL.

The water level at the start and stop and the average for each test, as well as the maximum and minimum readings taken, are given in the table of data and results.

In starting the second test of the Stirling boiler on December 7th, the rate of evaporation being 4½ pounds per square foot of heating surface, it was found necessary to carry the level of the water in the boiler higher than it was carried during the remainder of the test, two attempts being made to determine the water level with the fires out before the start was finally made. In one case the water level under steam was 6¾ inches and in the second 7 inches, but in both instances the water level dropped below the bottom of the glass when the fires were put out. The test was started on the third trial with the water level under steam 10½ inches and at the end of the three minute interval 6¾ inches.

The drop in the level in this case was 3¾ inches, the feed pump having been speeded up and the fires lowered just previous to putting out the latter. The same method was followed at the end of the test and at the start and stop of subsequent tests on the Stirling boiler.

It was not found necessary to raise the water level at the start and stop of the tests made on the Babcock & Wilcox boiler, the drop in level when the fires were put out being from ½-inch to a maximum of 2 inches at the end of the final test.

QUALITY OF STEAM.

The readings of the thermometers in the calorimeter throughout the tests were taken immediately after the water level in the gauge glass was noted. During the last twenty minutes of the tests of the Stirling boiler made on December 7th, 17th and 19th, while the water was being raised and lowered near the top of the glass, the calorimeter indicated moisture in the steam varying from 3.5 per cent. to an amount beyond the limits of the instrument.

At other times during the tests similar observations of water level and calorimeter temperature were taken. With the level of water in the glass 1¼ inches lower than during the latter portion of the last hours, the moisture in the steam did not exceed .5 of 1 per cent., except in one instance, which was .67 of a per cent., observed on December 19th.

The quality of steam furnished by the Babcock & Wilcox boiler was not affected by the height at which the water level was carried in the boiler, but the steam remained dry within a small fraction of 1 per cent. at all times. This was shown particularly during the first two hours of the final test for maximum capacity, when the Babcock & Wilcox engineer intentionally pumped the water up to the top of the glass. During the time of raising and lowering the water level, and for a period of twenty minutes while the water stood at the top of the glass, the moisture in the steam did not exceed .14 of 1 per cent. The readings on the thermometer, as well as the water levels, were continuously noted by the committee during this period.

EFFICIENCY.

The efficiency as determined by the committee is based upon the heat absorbed by the boiler as represented by the water evaporated into dry steam from and at 212 degrees Fahrenheit per pound of oil corrected for moisture, compared with the heat value of the oil per pound corrected for moisture. The same result would be obtained if the evaporation per pound of oil as fired were compared with the heat value per pound of oil as fired, no correction for moisture in the oil being made.

The increase in the heat value of the oil due to heating the same before delivery to the burners was calculated and found to be so small as to be negligable.

The heat balance has not been included in the report, as full data for computing the same were not taken by the committee. The effect, however, of the varying amounts of steam used for atomizing the oil has been considered and found to be so small that it may be neglected when compared with the heat value of the oil as fired.

DIAGRAMS.

The three diagrams accompanying the report show the relative amounts of water evaporated corresponding to the oil burned during the first six tests of the series, or, in other words, the relative evaporation for a given quantity of oil burned under each boiler. The points at the beginning and the end of the lines showing the amount of water evaporated were determined from the water levels taken with the fires out. The intermediate points were determined from the water levels under steam.

Respectfully submitted,

H. M. BOON,
Representing the Stirling Company.

E. H. PEABODY,
Representing the Babcock & Wilcox Company.

C. L. CORY.

San Francisco, Cal., February 8, 1904.

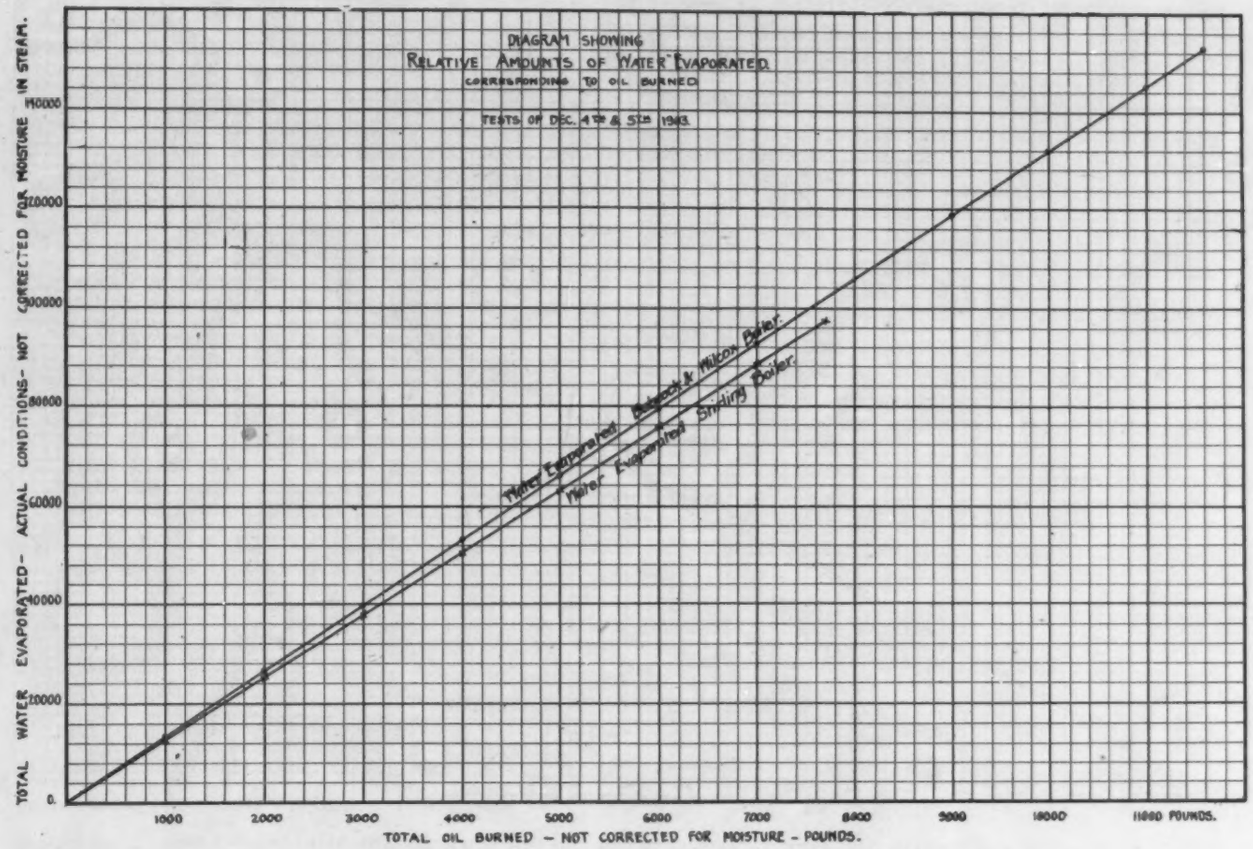
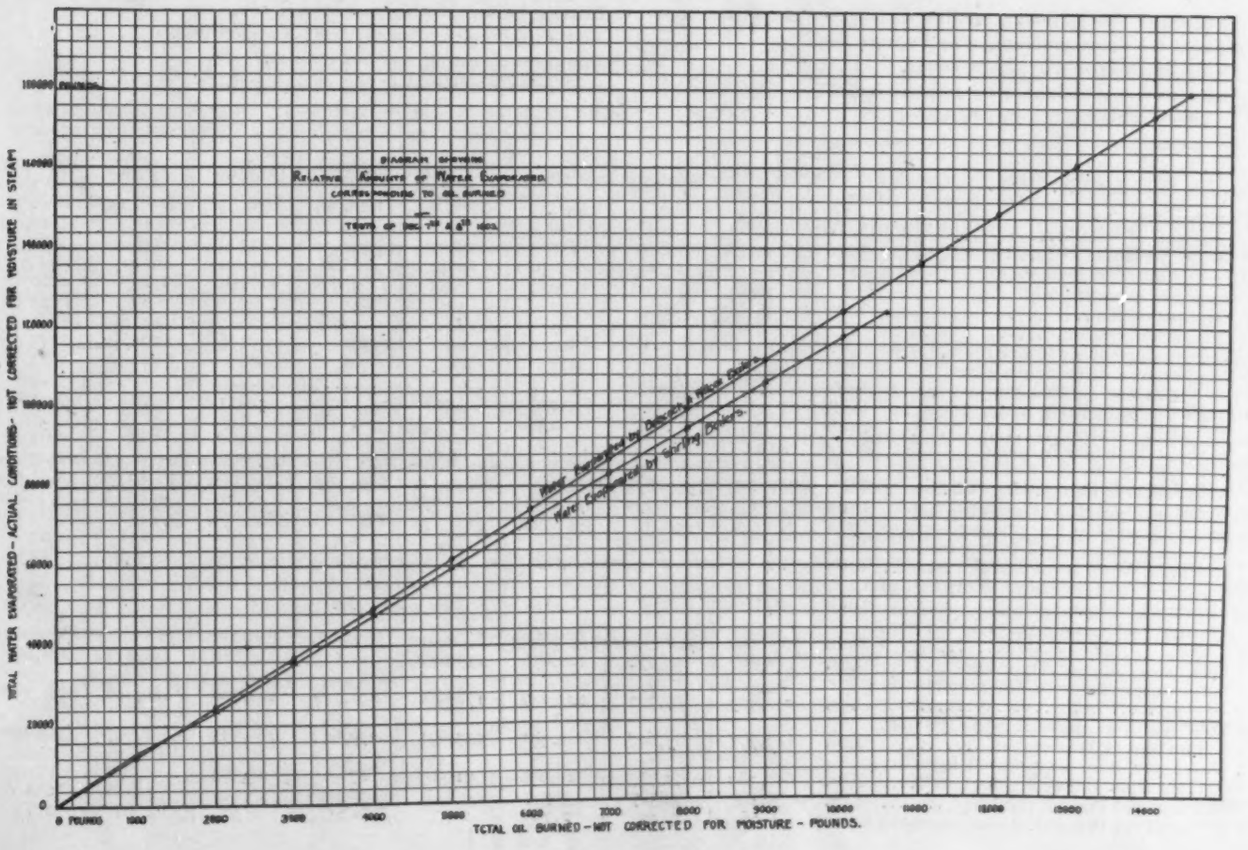
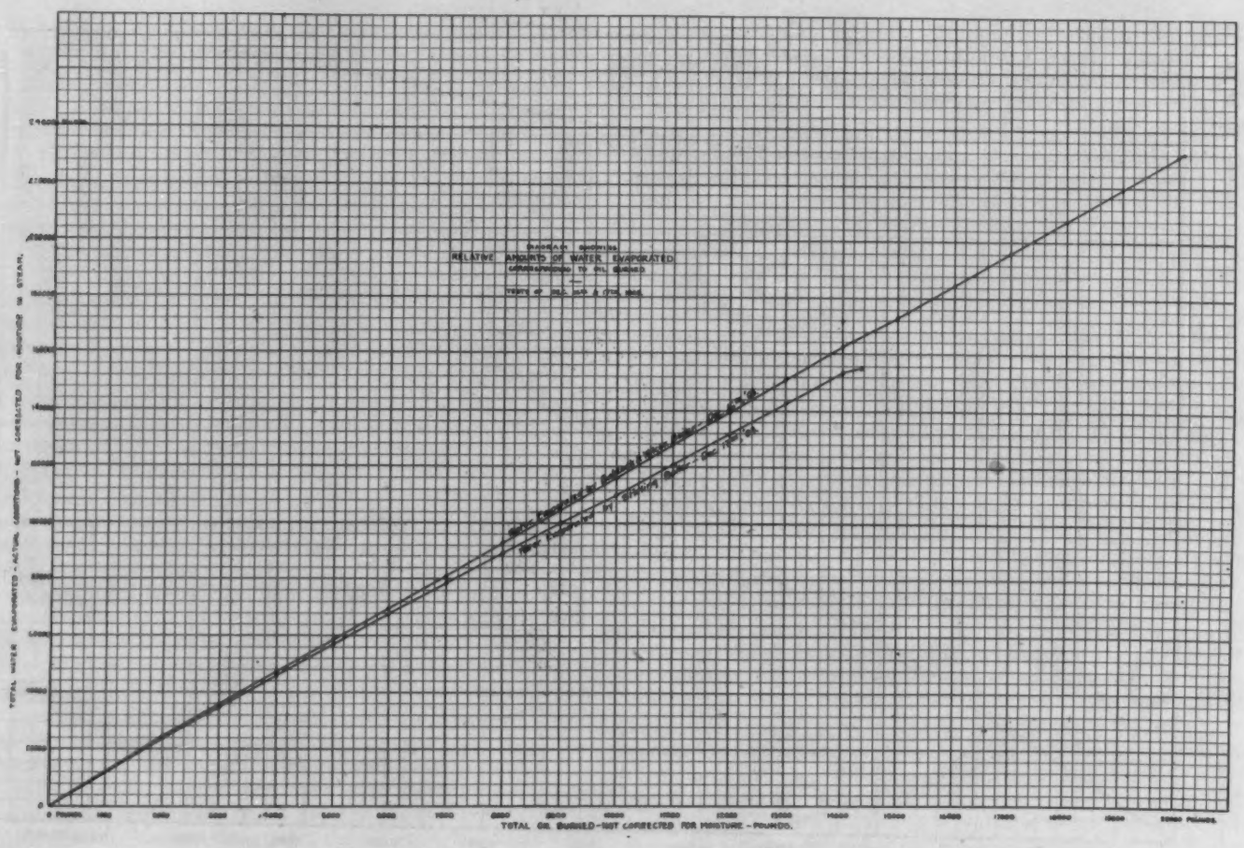


DIAGRAM SHOWING
RELATIVE AMOUNTS OF WATER EVAPORATED
CORRESPONDING TO OIL BURNED
TESTS OF DEC. 4TH & 5TH 1903.
TOTAL WATER EVAPORATED - ACTUAL CONDITIONS - NOT CORRECTED FOR MOISTURE IN STEAM.
Water Evaporated Babcock & Wilcox Boiler
Water Evaporated Stirling Boiler
0
20000
40000
60000
80000
100000
120000
140000
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000 POUNDS.
TOTAL OIL BURNED - NOT CORRECTED FOR MOISTURE - POUNDS.


TOTAL WATER EVAPORATED - ACTUAL CONDITIONS - NOT CORRECTED FOR MOISTURE IN STEAM
0
20000
40000
60000
80000
100000
120000
140000
0 POUNDS
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
TOTAL OIL BURNED - NOT CORRECTED FOR MOISTURE - POUNDS.



DATA AND RESULTS COMPETITIVE TESTS BETWEEN BABCOCK & WILCOX AND STIRLING BOILERS.
PACIFIC LIGHT AND POWER COMPANY, LOS ANGELES, CALIFORNIA.

Babcock & Wilcox boiler, heating surface and rated capacity—
Committee's measurement, 4774.6 square feet.
Committee's rating, 477 horsepower.
Builder's specifications, 4669.5 square feet.
Builder's rating, 467 horsepower.

Stirling boiler, heating surface and rated capacity—
Committee's measurement, 3287.8 square feet.
Committee's rating, 329 horsepower.
Builder's specifications, 3347 square feet.
Builder's rating, 335 horsepower.

Name of boiler		Babcock & Wilcox		Stirling		Stirling		Babcock & Wilcox		Babcock & Wilcox		Stirling		Stirling		Babcock & Wilcox	
Date of test, 1903		Dec. 4		Dec. 5		Dec. 7		Dec. 8		Dec. 16		Dec. 17		Dec. 19		Dec. 21	
Duration of test	Hours	10		10		10		10		10		10		10		10	
Steam pressure	Lbs.	156.4		156.0		156 4		156.2		156.9		157.0		156.3		157.3	
Temperature of feed water	F°	62.65		63.65		63.70		62.54		61.10		62.00		62.05		60.92	
Factor of evaporation		1.2050		1.2039		1.2039		1.2051		1.2067		1.2058		1.2056		1.2070	
Pressure of oil	Lbs.	36		25		32		50		46		63		60		55	
Temperature of oil	F°	109½		88		85		124		132		128		104½		111	
Temperature of air in fire room	F°	87½		95½		100		94		100		101½		105½		103	
Temperature of escaping gases	F°	438		454		517		464		525		606		720		622	
Draft: In flue outside damper	Inch	.....		.....		.....		.....		.....		.....		.66		.49	
Draft: Near damper, boiler side	Inch	.08		.14		.20		.15		.29		.25		.34		.49	
Draft: In furnace	Inch	.02		.09		.15		.05		.12		.13		.15		.15	
Per cent. moisture in steam	Pr cnt	0.21		0.56		0.52		0.14		0.16		0.58		0.69		0.14	
		Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish
Water level before putting out fires	Inch	5¾	6¾	7⅜	6⅝	10½	13	6¾	7¾	5¾	5½	10½	13¾	13	11¼	5¾	6⅛
Water level after fires were out 3 min.	Inch	5¼	6	5	3⅜	6¾	8¾	6⅛	7⅛	4	4	1	8	⅜	¾	4¾	4⅛
Drop in water level on putting fires out	Inch	½	¾	2⅜	3	3¾	4¼	⅜	⅝	1¾	1½	9½	5¾	12⅜	11	1	2
Maximum water level during test	Inch	7		7⅜		13		7¾		6¼		13¾		13		10	
Minimum water level during test	Inch	4		2		3½		5		4		1		¼		4⅛	
Average Level During Test: Inches above bottom of glass	Inch	5¾		5⅛		5½		6⅝		5¼		8		6⅛		6¼	
Average Level During Test: Inches above or below center of glass	Inch	¼ above		1⅞ below		1½ below		1⅜ above		¼ above		1 above		⅞ below		1¼ above	
Total water apparently evaporated	Lbs.	152,850		98,272		124,896		179,233		232,113		155,682		190,513		281,630	
Total water corrected for moisture in steam	Lbs.	152,529		97,722		124,247		178,982		231,742		154,779		189,198		281,236	
Total water evaporated into dry steam from and at 212 degrees	Lbs.	183,797		117,648		149.581		215,691		279,643		186,633		228,097		339,452	
Water per hour evaporated into dry steam from and at 212 degress	Lbs.	18,380		11,765		14,958		21,569		27,964		18,663		22,810		33,945	
Steam used by burners: Pounds per hour	Lbs.	342.6		383.7		387.7		479.8		604.0		444.4		456.8		588.0	
Steam used by burners: Percent. steam generated	Pr cnt	1.96		3.42		2.72		2.33		2.27		2.50		2 10		2.13	

		Whittier		Mixture of Whittier and Los Angeles				Whittier	
Kind of oil burned									
Specific gravity of oil, 60 degrees F.	Sp Gr	.9417	.9430	.9530	.9529	.9637	.9629	.9410	.9407
Specific gravity of oil by Beaumé scale	Deg.	19.05	18.83	17.17	17.18	15.48	15.60	19.17	19.22
Per cent. of moisture in oil	Pr cnt	1.06	1.06	4.93	4.62	8.71	8.82	.74	.42
Heat value of oil as fired, B. T. U. per pound		18,428.4	18,478.8	17,791.2	17,887.5	16,904.7	16,956.0	18,567 0	18,578.7
Heat value of oil corrected for moisture		18,626	18,677	18,714	18.754	18,518	18,596	18,705	18,657
Total oil as fired	Lbs.	11,597.5	7,764.0	10,577.0	14,441.5	20,127.0	14,361.5	16,585.5	23,966.5
Total oil corrected for moisture	Lbs.	11,474.6	7,681.7	10,055.7	13.774.3	18,373.9	13,094.8	16,462.8	23,865 8
Oil per hour as fired	Lbs.	1,160	776	1,058	1,444	2,013	1,436	1,659	2,397
Oil per hour corrected for moisture	Lbs.	1,147	763	1,006	1,377	1,837	1,309	1,646	2,387
Water evaporated per square foot of heating surface from and at 212 deg. per hour. Committee's measurement	Lbs.	3.85	3.58	4.55	4.52	5 86	5.68	6.94	7.11
Water evaporated per square foot of heating surface from and at 212 deg. per hour. Builder's specifications	Lbs.	3.94	3.52	4 47	4 62	5.99	5.58	6.82	7.27
Horsepower developed	H. P.	532.7	341.0	433.6	625.2	810 6	541.0	661 2	983.9
Per cent. above committee's rating	Pr cnt	11.69	3.65	31.78	31.07	69.93	64.43	100.96	106 27
Per cent. above builder's rating	Pr cnt	14.08	1.79	29.42	33.87	73.57	61.48	97.36	110.69
Water evaporated per pound of oil from and at 212 degrees. Oil as fired	Lbs.	15.849	15.153	14.142	14.936	13.894	12.995	13.753	14.164
Water evaporated per pound of oil from and at 212 degrees. Corrected for moisture	Lbs.	16.02	15.31	14.87	15.66	15.22	14.26	13.85	14.22
Efficiency	Pr cnt	83.06	79.16	76.73	80.64	79.37	74.05	71.50	73.62

The Committee: H. M. BOON, Representing the Stirling Company. E. H. PEABODY, Representing the Babcock & Wilcox Co. C. L. CORY.

SUMMARY OF PRINCIPAL RESULTS OF COMPETITIVE TESTS BABCOCK & WILCOX VS. STIRLING BOILERS, LOS ANGELES, CAL., 1903.

Test	Boiler	Rate of evaporation	Horsepower	Per cent. above builder's rating	Per cent. moisture in steam	Temperature of escaping gases	Evaporation per pound of oil from and at 212°	Per cent. steam used by burners	Efficiency	Per cent. gain in efficiency B. & W. over Stirling
First test	Babcock & Wilcox	3.85	532.7	14.1	0.21	438	16.01	1.96	83 06	4.93
First test	Stirling	3.58	341.0	1.8	0.56	454*	15.31	3.42	79.16	
Second test	Babcock & Wilcox	4.52	625.2	33.9	0.14	464	15.66	2.33	80.64	5.10
Second test	Stirling	4.55	433.6	29.4	0.52	517	14.87	2.72	76.73	
Third test	Babcock & Wilcox	5.86	810.6	73.6	0.16	525	15.22	2.27	79.37	7.18
Third test	Stirling	5.68	541.0	61.5	0.58	606	14.26	2.50	74.05	
Capacity test	Babcock & Wilcox	7.11	983.9	110.7	0.14	622	14.22	2.13	73.62	2.97†
Capacity test	Stirling	6.94	661.2	97.4	0.69	720	13.85	2.10	71.50	

*See Plate II.

†The last two tests were made to show the maximum capacity that could be obtained under the conditions existing at the plant and the effect on the boiler of this forcing. The conditions conducive to the best efficiency were necessarily disregarded in order to obtain the maximum capacity.

The rate of evaporation shown in the third column is given in pounds of water evaporated into dry steam from and at 212 degrees per hour per square feet of heating surface as measured by the committee. The evaporation per pound of oil in the eighth column is for oil corrected for moisture, and is given in pounds of water evaporated into dry steam from and at 212 degrees Fahrenheit. All results are corrected for moisture in the steam.

The Committee: H. M. BOON, Representing the Stirling Company. E. H. PEABODY, Representing the Babcock & Wilcox Co. C. L. CORY.

REPORT OF CHEMIST.

BERKELEY, CAL., January 11, 1904.

Messrs. H. M. Boon, E. H. Peabody and C. L. Cory:

DEAR SIRS—In accordance with your letter of instructions, dated Los Angeles, Cal., December 18th, I have examined the eight samples of fuel oils and present herewith my report on the same.

The samples were all received in good order, with seals unbroken, and have been kept under my personal observation or under lock and key since receipt. In every case the cans have been shaken violently or stirred before removing the samples for the different tests.

The calorific values were made in an Atwater bomb calorimeter apparatus, and in all essential details I have followed the method outlined by Atwater and Snell in the *Journal of the American Chemical Society*, Volume XXV, page 659, July, 1903. The hydrothermal value of the bomb and accessories was determined by combustion of weighed amounts of pure napthalene, camphor and cane sugar, and the average value obtained from these tests used in the calculations. It was found to be impossible to obtain complete combustions of the oils when they were ignited in an open vessel, hence the sample was weighed out in a small gelatine capsule, the whole ignited, and the proper allowance made for the heat of combustion of the gelatine. This method gave in all cases complete combustion. The sulphur was determined by rinsing out the bomb, precipitating the resulting sulphuric acid as barium sulphate, and weighing the latter. The total acidity of the bomb rinsings was determined by titrating the solution with a standard solution of potassium hydrate, the acidity thus found diminished by the acidity due to the sulphuric acid, and calorific value of the residual nitric acid calculated. To illustrate the manner of making the determination clear to you, I include in my report a sheet showing the details of one of the determinations.

The water was first determined, in accordance with the suggestion in your letter of instruction, by adding 100 cc. of oil to 500 cc.

of gasoline, shaking and allowing to stand for twenty-four hours, filtering, again allowing to stand and measuring the volume of water. This method was found to be entirely inaccurate, and all the results obtained by it discarded. On diluting the oils large amounts of silt and suspeneed organic matter separate out, rendering it impossible to measure the volume of water with even approximate accuracy, and on filtering appreciable amounts are retained by the insoluble substances. The method actually used was to heat 100 cc. of the oil in a distillation flask gradually to a temperature of 150 degrees, collect the distillate in a graduated tube and measure the resulting water. This method insures complete removal of the water, reduces to insignificant proportions the error resulting from a slight solubility of the water in gasoline, and avoids the error involved in the transference from one vessel to another. Samples 113 and 116 gave by the dilution method 6.25 and 6.26 per cent. respectively, by the distillation method 8.71 and 8.82 per cent. respectively.

The insoluble matter resulting from a dilution with gasoline was ignited and weighed in a platinum dish and reported as percentage of "silt." It is possible that the filter papers employed did not retain absolutely all of the suspended inorganic matter, but the results would give, I think, a relative value for all such matter that would be liable to settle out from the oil within a reasonable length of time.

In order to compare the oils with other samples for which we have analytical determinations, the specific gravities were determined at a temperature of 15 degrees.

Finally, it has seemed to me unnecessary to make elementary analyses of any of the samples, as the percentage errors involved in the latter are quite as large as those involved in the heat determinations.

Respectfully submitted,

W. C. BLASDALE.

CALORIMETER TESTS OF SAMPLES OF FUEL OIL.—REPORT OF PROF. W. C. BLASDALE.

Number of samples	*Date 1903	Heat value of oil			Per cent. Sulphur	Per cent. Moisture	Per cent. Silt	Specific gravity
		Colories per gram		B. T. U. per pound average				
		Actual results	Average					
113	Dec. 16	9,378	9,391.5	16,904.7	.85	8.71	.032	.9637
113		9,405			.84			
114	Dec. 21	10,314	10,321.5	18,578.7	....	.42	.010	.9407
114		10,329			.96			
115	Dec. 4	10,247	10,238.0	18,428.4	.96	.106	.031	.9417
115		10,229			.99			
116	Dec. 17	9,407	9,420.0	16,956.0	....	8.82	.024	.9629
116		9,433			.84			
118	Dec. 5	10,252	10,266.0	18,478.8	.70	.106	.010	.9430
118		10,280			.77			
119	Dec. 19	10,316	10,315.0	18,567.0	....	.74	.024	.9410
119		10,314			1.01			
120	Dec. 8	9,929	9,937.5	17,887.5	.93	4.62	.048	.9529
120		9,946			.98			
129	Dec. 7	9,871	9,884.0	17,791.2	...	4.93	.054	.9530
129		9,897			.98			

*Date of test corresponding to sample inserted by committee.

DETAIL OF CALORIMETER TEST OF SAMPLE NO. 129 (A).

Readings—

1 = .362
2 = .364
3 = .368
4 = .368
5 = .371
6 = .374

Initial period—
Total fall = .012
Rate = .0024 = γ
Mean of 1 and 6 = .368 = θ

Combustion period—
7 = 2.300
8 = 3.800
9 = 3.896
10 = 3.896
11 = 3.890

Mean of 6 and 11 = 2.132
Sum of 7, 8, 9 and 10 = 13.892
16.024
5 times θ = 1.840
14.184

Final period—
12 = 3.885
13 = 3.880
14 = 3.876
15 = 3.872
16 = 3.869

Total fall = .021
Rate = .0042 = γ^1
Mean of 11 and 16 = 3.8795 = θ^1

Water used in calorimeter = 1666 grams
Hydrothermal value of calorimeter = 434 grams
2100 grams

Nitric and sulphuric acid = 7 cc. .15 N-KOH solution
B_2SO_4 = .0471 grams = .0065 s.
7 × 2.15 = 15.05 = Calorific value of acids
.0065 × 3.94 ÷ .0044 = 5.8 = Calorific value H_2SO_4

Accessories—
Iron = .0178 × 1600 = 28.48
Gelatine = .1753 × 4370 = 766.06
Nitric acid = 15.05 — 5.58 = 9.25
803.79

$$\theta^1 - \theta = 3.5115$$
$$\gamma^1 - \gamma = .0066$$
$$\frac{14.184 \times .0066}{3.8795} = .0266$$
$$.0266 - (5\ \gamma)\ .0120 = .0146 = \text{Radiation correction}$$
$$3.890 - .374 = 3.516 = \text{Rise in temperature}$$
$$3.516 + .0146 = 3.5306 = \text{Corrected rise in temperature}$$

$$3.5306 \times 2100 = 7414.2$$
$$7414.2 - 803.79 = 6610.41$$
$$6610.41 \div .6679 = 9897 = \text{Calories per gram}$$

Weight of oil used, .6679 grams; gelatine, .1753 grams; iron wire, .0178 grams.

ARTICLES OF AGREEMENT.

Articles of agreement between Pacific Light and Power Company, Los Angeles, Cal.; the Babcock & Wilcox Co., by Chas. C. Moore, manager Pacific Coast office; the Stirling Company, Chicago, Ill., regarding conditions of making certain tests upon Babcock & Wilcox boilers and Stirling boilers at the power plant of the Pacific Light and Power Company, Los Angeles, California.

ARTICLE I.

The tests shall be conducted by a committee consisting of three engineers appointed and paid as follows:

One engineer shall be appointed and paid by the Babcock & Wilcox Co.; one engineer shall be appointed and paid by the Stirling Company; these two shall select the third engineer, who shall be paid one-half by the Babcock & Wilcox Co. and one-half by the Stirling Company.

In the event of any dispute or disagreement between the two engineers representing the Babcock & Wilcox Co. and the Stirling Company, respectively, the point under dispute shall be passed upon by the third engineer, whose decision shall be final and be accepted by all parties to this agreement.

Whenever the word "committee" shall occur in this agreement it shall mean the committee of three engineers as above specified.

ARTICLE II.

The committee shall have absolute charge of all details of the boiler tests, including the connecting up or installation of the apparatus and appliances necessary to make the tests, and the committee shall be authorized to exclude from the vicinity of the boiler or boilers under test, and the testing apparatus, any and all persons not directly under their charge. After completion of the official tests the committee shall make a complete report of every official test, together with a summary of the results of these tests, and furnish an official copy to each party to this agreement.

ARTICLE III.

The Babcock & Wilcox Co. and the Stirling Company, through the engineers representing them, shall each appoint a set of observers, so that every observation taken shall be noted and recorded by two persons, and each set of observers shall be paid by the company by which it is appointed.

ARTICLE IV.

The Pacific Light and Power Company shall place under the absolute charge of the committee such boiler or boilers as may be under test, such control to hold until the test is completed. It being understood that the tests shall be conducted in such a manner as not to deprive the Pacific Light and Power Company of the use of the boiler during this or in any way interfere with the normal operation of the plant.

ARTICLE V.

The Pacific Light and Power Company shall grant to both the Babcock & Wilcox Co. and the Stirling Company the privilege of making a complete internal and external inspection of their respective boilers, before the beginning of the official tests, and to correct any defects found, to make any necessary adjustment of parts, and to run the preliminary tests necessary to effect or determine such adjustments. Previous to beginning of official tests and at any time during or immediately after the official tests, the committee or any member thereof shall have access to any and all parts of the boiler or boilers under test or to be tested, and of the apparatus used in making the tests.

ARTICLE VI.

The instruments of precision necessary to enable the tests to be made shall be furnished by the Babcock & Wilcox Co. and the Stirling Company, as may be agreed upon between the two engineers representing these companies, and the standardizing or checking of this apparatus shall rest entirely with the committee.

ARTICLE VII.

The Pacific Light and Power Company shall without cost to the Babcock & Wilcox Co. or to the Stirling Company place at the disposal of the committee its shop facilities and mechanical force for the purpose of setting up the apparatus necessary for making the tests, and for removing this apparatus when tests have been completed.

ARTICLE VIII.

The Pacific Light and Power Company shall furnish at its own expense all fuel oil needed during the tests. The samples of oil taken during the tests shall be subjected to calorimeter tests to determine the calorific value per pound of oil, the calorimeter tests being made by some recognized authority in such work designated by the committee. The expense of such analyses shall be paid one-third by each of the parties to this agreement.

ARTICLE IX.

Before the beginning of the official tests, each party to this agreement shall transmit to the committee a written statement defining the precise scope he desires the tests to cover. The committee shall then draw up in writing an exact statement defining the points to be covered by the tests and the order and manner of making the tests, and the program thus laid out shall not be departed from in the subsequent work except upon written agreement of each member of the committee.

ARTICLE X.

Conditional upon the acceptance of this agreement by all three parties to it on or before October 7, 1903, the official tests shall begin not later than November 1, 1903, and be completed with least possible delay. Once the official tests have been started, no postponement shall be permitted except upon the written consent of each member of the committee.

We agree to each of the ten articles as above set forth.

PACIFIC LIGHT AND POWER COMPANY,
By A. C. Balch.

THE BABCOCK & WILCOX COMPANY,
By Chas. C. Moore, Manager
Pacific Coast Department,
By Elgin Stoddard.

THE STIRLING COMPANY,
By Edgar Kidwell, Pacific Coast Manager.

STATEMENTS FROM THE THREE PARTIES TO AGREEMENT IN ACCORDANCE WITH ARTICLE IX.

[Pacific Light and Power Company.]

LOS ANGELES, CAL., October 21, 1903.

Edgar Kidwell, Esq., San Francisco, Cal.:

DEAR SIR—Replying to your favor of the 16th inst., I would say that I have been out of the city, which accounts for the delay in answering.

I am in receipt of the following telegram from you:

"Test committee cannot act further until receive your reply my letter sixteenth. Reply quick giving your wishes concerning scope of test."

To which I replied as follows:

"We want test for efficiency, capacity and quality of steam."

Very truly yours,

A. C. BALCH, Manager.

[The Babcock & Wilcox Company]

SAN FRANCISCO, October 22, 1903.

To the Committee Appointed to Conduct Tests on Stirling Boilers and Babcock & Wilcox Boilers at Los Angeles:

GENTLEMEN—In accordance with Article IX of the agreement between the Pacific Light and Power Company, of Los Angeles, the Babcock & Wilcox Co., by Chas. C. Moore, manager Pacific Coast office, and the Stirling Company, of Chicago, Ill., we beg to state that the scope we desire to have the above tests cover is as follows:

First—A test on each boiler at a rate of evaporation of 3½ to 4 pounds of water from and at 212 degrees Fahrenheit per square foot of heating surface per hour for the purpose of determining the efficiency of the boilers at that capacity. Inasmuch as the setting of the boilers is one of considerable importance to the purchaser, we desire to have the question of efficiency cover that of the boiler and furnace combined. In other words, we desire to have the amount of steam used by the burners measured and a statement made of the net evaporation per pound of oil after deducting the proportionate amount of steam used for atomizing. The gross evaporation would then determine the efficiency of the boiler and the net evaporation would determine the efficiency of the boiler and furnace combined.

Second—We desire to have the tests cover the question of efficiency of the boiler and furnace under forced conditions, and suggest that tests be made on each boiler at or near a rate of evaporation of 5¾ pounds of water per hour from and at 212 degrees Fahrenheit per square foot of heating surface; the efficiency to be determined in these tests in the same way as in the first tests.

Third—We would like to have determined the maximum capacity at which it would be practicable to operate the boilers under conditions prevailing during a peak load, or during an emergency, in which the greatest possible output of steam would be demanded from the boilers in operation. We would wish to have the efficiency determined during these tests the same as in those mentioned above.

Fourth—We consider a question of the quality of steam produced by the boilers of great importance, and would like to have this point carefully observed and the reported evaporation corrected for any moisture entrained in the steam. In other words, we desire to have the usual correction made for wet steam.

Fifth—Inasmuch as the use of oil for fuel may entail great danger to the boiler if the setting is not adapted to its use, especially under conditions of high capacity, we desire to call attention to the fact that the setting of the Babcock & Wilcox boiler is of such construction that there is no danger of local overheating or burning out of tubes due to blow-pipe action of the flame, and we would like to have this point observed by the committee and fully reported upon.

We have taken up these points in detail, as we understand that the object of these tests is to satisfy the Pacific Light and Power Company as to the comparative merit of the boilers and the fitness of each as a steam generator for use with oil fuel. We believe that it would be essential to have all the above points covered in your report to fully determine the question.

Very truly yours,

THE BABCOCK & WILCOX CO.,
Chas. C. Moore, Manager
Pacific Coast Office.
Per Elgin Stoddard.

[The Stirling Company]

SAN FRANCISCO, October 22, 1903.

To the Committee on Tests, 331 Pine Street, City:

GENTLEMEN—In compliance with Article IX of the articles of agreement concerning tests on boilers at Pacific Light and Power Company's plant in Los Angeles, we beg to hand you a statement defining the scope we desire the tests to cover, and the conditions under which the tests should be made.

We desire each test made of boiler to be subjected to the following named tests, viz.:

First—A test when boiler is operating at rating.

Second—A test when boiler is operating 30 per cent. above rating.

Third—A test when boiler is operating with an overload not less than 75 per cent. above rating.

We desire that each test be not less than ten hours in duration, and that for each test the boiler efficiency and the quality of steam be determined.

We desire each make of boiler to be subjected to duplicate tests, under duplicate conditions, each boiler being equipped with the same pattern of oil burner.

We desire that during the tests each boiler shall be operated by the engineer representing the manufacturers of that boiler.

We desire that all measurements be positive to eliminate possibility of error. For example, all boiler feed water and all fuel oil used during the tests shall be accurately weighed and not metered.

Inasmuch as these tests have grown out of the claim of the representatives of the Babcock & Wilcox Co. that their boiler is and can be proved to be superior to the Stirling boiler alike in efficiency, capacity and quality of steam, it devolves upon the Babcock & Wilcox Co. to make such tests as they deem essential to substantiate their claims. When they have thereby obtained such results as to their own satisfaction prove their claim, the Stirling Company shall then follow with such parallel tests as may be necessary to afford final and unquestionable comparison with the tests on the Babcock & Wilcox boilers, and to enable the committee to determine and state which make of boilers has proven itself the better as to efficiency, capacity and quality of steam, as provided in Article II of the articles of agreement.

Very respectfully submitted,

THE STIRLING COMPANY,
Edgar Kidwell, Pacific Coast Manager

THE H. W. JOHNS-MANVILLE COMPANY.

A convention of branch managers, department managers and salesmen of the H. W. Johns-Manville Company was in session from February 15–20, 1904. Representatives to the number of about thirty-five from all parts of the country were present, the company having branches in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Cleveland, Pittsburg, New Orleans, London.

The delegates first met in Hartford, where they were the guests of the Johns-Pratt Company, manufacturers of the famous Sachs "Noark" enclosed fuses, line materials and other electrical goods for which the H. W. Johns-Manville Company are sole agents.

The object of the convention was to bring all branches into closer touch with each other and to give opportunity for a general discussion of all the enormously varied lines manufactured by this company.

YOLO COUNTY ELECTRIC RAILWAY.

A project is on foot and the money ready for surveys for an electric railroad from Knight's Landing on the Sacramento River, westerly to Woodland and Winters, thence southerly to Vacaville and Suisun. Interests identified with the Bay Counties Power Company are said to be back of the project. The road will carry freight and passengers. It is understood that the steam sloops now running to Suisun will connect with the new road, thus giving an outlet for freight to this city. An effort will be made to induce Congress to improve and deepen the channel between Suisun and Suisun Bay.

SINGLE-PHASE MOTORS AS A MEANS OF INCREASING STATION EARNINGS*.

BY W. A. LAYMAN.

AN electric central station, with its auxiliary distribution system, is a manufacturing plant, and the same general principles of operation apply to it as to any other form of factory. There must be the greatest possible simplification of output; the production must be maintained on as nearly uniform a basis as possible; the full productive capacity must be sold and all by-products must be utilized in every available way. Until a few years ago electric central stations were essentially lighting stations, and many of them came into existence to do municipal street lighting work. Little or no thought was given to the expansion of the legitimate functions of the electric central stations in other directions. Today conditions are materially changed. Companies are incorporated as light, heat and power companies. The principle has become most emphatically and thoroughly established that other kinds of business are equally desirable with lighting load.

As illustrating this tendency, the writer is able to present herein, through the courtesy of Louis Ferguson, of the Chicago Edison Company, lighting and power load curves of that company, extending over a period of four and one-half years. Figure 1.

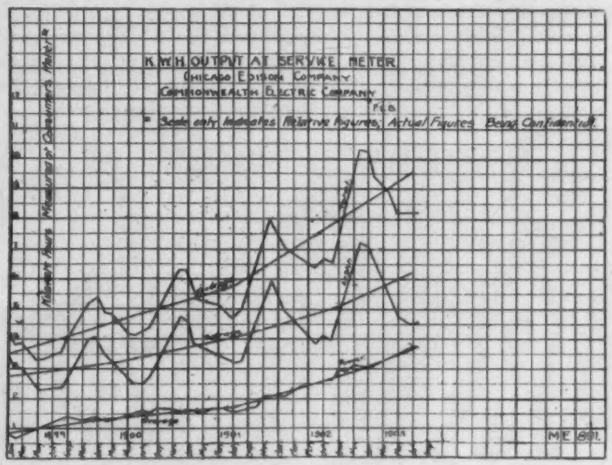


FIGURE 1. KILOWATT-HOUR OUTPUT AT SERVICE METER OF THE CHICAGO EDISON COMPANY AND THE COMMONWEALTH ELECTRIC COMPANY

Referring to the curves, it will be observed that on January 1, 1899, the average power load was but 24.3 per cent. of the total load, and only 31.2 per cent. of the lighting load. Observe the remarkable development of the power business, between that time and July 1, 1903, at which time the average power load was 46.5 per cent. of the total load and 66.5 per cent. of the lighting load. In other words, while the lighting load had increased 124 per cent., the motor load had increased 335 per cent. The magnificent increase of the total business of the Chicago Edison Company is also worthy of consideration in passing. The total load, including both lighting and motor service, had increased 156 per cent. during this interval of four and one-half years. These loads are plotted on the basis of kilowatt hours metered on the customer's premises. Considering the tremendous volume of the Chicago Edison Company's business January 1, 1899, this gain represents a very remarkable achievement, and one illustrative of splendid management. What the Chicago Edison Company is doing in the way of developing power business is indicative of a policy being pursued generally all over the country.

For the majority of central station companies usually represented in conventions, the vital question therefore at once arises as to the best policy to pursue in laying out development work, having the end in view of accommodating the system of generation and distribution to the most economical combined power and lighting service.

The economical operation of central stations is inevitably drifting toward the ideal basis of generation of one form of current, and the development by every possible means of a higher load factor. Further than this, operating engineers are specifying the installation of consuming devices which afford the lowest first cost and the simplest possible means of distribution. The single-phase alternating-current motor lends itself readily to the develment of this general scheme in ways which it is the purpose of this paper to briefly set forth. The following concise statement of facts will be accepted, the writer believes, by all central station men who are familiar with the performance of the single-phase alternating-current motor, built by the Wagner Electric Manufacturing Company:

First—The single-phase motor has reached a high stage of mechanical and electrical development, and is today thoroughly reliable for all kinds of power service, excluding those involving frequent starting and stopping and speed variation.

Second—The average single-phase motor is equal in its electrical characteristics to any other form of electrical motor.

Third—The single-phase motor calls for less inspection and maintenance expense than any direct-current motor on the market, and for no larger inspection or maintenance expense than the best polyphase motor.

Fourth—The operating engineer of a moderate sized central station would prefer single-phase distribution as a means of eliminating unending troubles in balancing of loads, and therefore he would greatly prefer to install single-phase motors for all possible kinds of power service.

The writer of this article is an advocate of the following arrangement of central station service:

(*a*) For Large Plants: Polyphase generators, with switchboard arranged for operating—

First—Polyphase feeders for all large power and rotary converter service.

Second—Single-phase feeders for all general lighting service, and for all small power work, the switchboard facilities being such that any single-phase feeder may be switched to either phase of the generator busses.

Third—Independent feeder regulators for all polyphase, as well as single-phase feeders.

(*b*) For Small Stations: Either single-phase generators with single-phase feeders, each feeder being operated with independent pressure regulator; or, polyphase generators, with single-phase feeders, which may be thrown by the proper switchboard devices to either phase of the generator, and each feeder provided with independent pressure regulators.

This policy with respect to station and distribution equipment is advocated with the conviction that the single-phase motor affords an alternating current, central station, polyphase or single phase—the ideal means of distributing small power. There may be a difference of opinion between the writer and central station engineers as to the scope of the term "small power"; but in the writer's belief it is a generally conceded fact that the single-phase motor is the central station man's best instrument to economical power service, up to units of a certain magnitude. The writer believes single-phase motors should receive the preference of the operating engineer of multiphase stations with no other restriction as to size than that imposed by service conditions. The limit of size is fixed naturally by the unbalancing effect produced between phases of a polyphase system. Polyphase stations of the writer's knowledge are successfully operating single-phase motors of thirty-five horsepower. Single-phase stations, with individual generators not exceeding seventy-five kilowatts capacity, are also sucessfully operating single-phase motors of thirty-five horsepower each.

It is probable that a large majority of central stations in this country are almost exclusivly using single-phase distribution, and

* A paper presented to the Ohio, Colorado and Southwestern Electric Light Association at the recent meeting.

there could be no justification for attempting polyphase distribution so long as single-phase motors will adequately take care of such power business as it is possible to develop. In fact, there are a number of very strong reasons why the polyphase type of motor is at a disadvantage as compared with the single-phase motor,

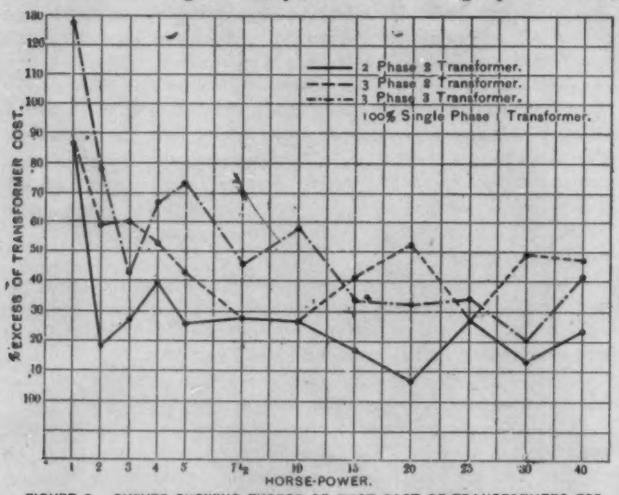


FIGURE 2. CURVES SHOWING EXCESS OF FIRST COST OF TRANSFORMERS FOR MULTI-PHASE MOTORS AS COMPARED WITH SINGLE-PHASE

viewed from the standpoint of the central station man. These reasons are as follows:

First—A polyphase motor requires at least two transformers, and sometimes, with three-phase motors, three transformers are used.

That this makes the first cost of transformers much larger for the polyphase than for the single-phase motors of the same size is clearly shown in Figure 2.

A careful inspection of these curves will show that under the very best conditions for polyphase power service the average first cost of transformers is at least 25 per cent. in excess of that for single-phase motors, and may be as high as 50 per cent.

Second—It is a well known fact that the internal losses of small transformers are very much larger in proportion to the capacity of the transformers than are the losses of large transformers. It therefore follows that the internal losses of two or three transformers for a polyphase motor will be very muc hgreater than the internal losses of a single-phase transformer of larger size, for the single-phase motor. The actual difference is shown in Figure 3. Where it again appears that under the best conditions for polyphase motors the average internal transformer losses are at least 20 per cent. greater than for a single-phase motor.

Further than this, the most favorable three-phase installation, considered from the point of average initial cost (Figure 2) is

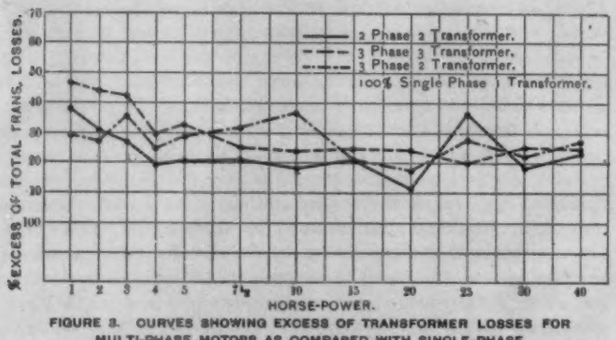

2 Phase 2 Transformer.
3 Phase 3 Transformer.
3 Phase 2 Transformer.
100% Single Phase 1 Transformer.
% EXCESS OF TOTAL TRANS. LOSSES.
HORSE-POWER.

FIGURE 3. CURVES SHOWING EXCESS OF TRANSFORMER LOSSES FOR MULTI-PHASE MOTORS AS COMPARED WITH SINGLE-PHASE

obtained by the use of two transformers; but in connecting two units to operate a three-phase motor it should not be forgotten that full energy on the two transformers gives a current overload of about 15 per cent., with an excess of about 30 per cent. copper loss over that for full load. The disadvantages therefore of any overload can readily be seen.

Third—The much more complicated line construction for polyphase motors adds greatly to the cost of service connection for the polyphase motor subscriber over that for a single-phase motor subscriber. The excessive cost of line material, together with the excess in cost of transformers, may easily make the total cost of equipment to serve a customer operating a polyphase motor as much as twice the first cost of service for a single-phase customer.

It can therefore be strongly asserted that the single-phase motor is the central station man's best friend in many ways.

Some of the conditions affecting satisfactory single-phase motor service may be profitably mentioned here.

The single-phase motor, as, in fact, any form of polyphase motor, varies much in capacity with the variation of voltage applied to the motor terminals. Figure 4 illustrates this characteristic in all alternating-current motors very forcibly. Station engineers should therefore be careful to maintain at least the normal rated motor pressure at the motor terminals. Any first class alternating-current motor is capable of withstanding an application of 10 or 15 per cent. excess voltage, the effect of this voltage being to slightly increase the heating with the advantage of materially increasing the load capacity. As bearing critically on this point of the proper motor voltage, mention may be made of the importance of the selection of the proper type of transformer. There are makes of transformers which have very poor regulation on motor load, with the result that a line pressure entirely satisfactory for lighting work becomes, through the medium of this transformer, too low for good power service. It

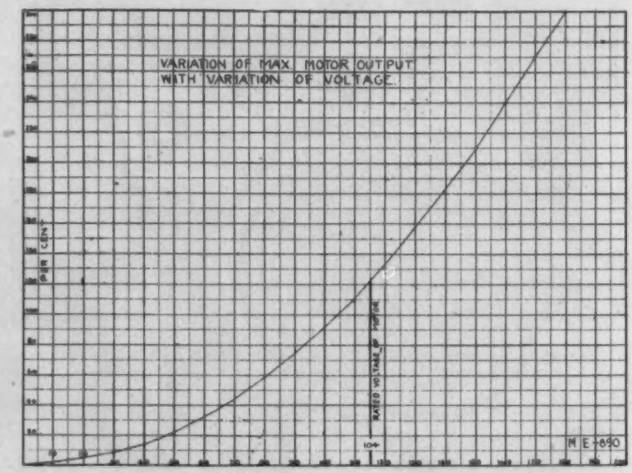


FIGURE 4. VARIATION OF MAXIMUM MOTOR OUTPUT WITH VARIATION OF VOLTAGE

is possible, by the right selection of transformers, to have a proper voltage for lighting work, entirely adequate for proper motor service, and the discriminating engineer will select his transformers with this end in view.

With small single-phase motors it is not especially necessary to use any kind of auxiliary starting device for holding down the starting current of the motor. The Wagner Electric Manufacturing Company's type of motor may be started with full pressure, the starting operation simply consisting of closing the line switch. When this is done, the starting current may run up at the first instant to two or two and one-half times full load current. If the capacity of the feeder is somewhat limited, and if there is a large lighting load on this same feeder, there may be some interference with the lighting if a motor of ten to thirty-five horsepower capacity is so started. In instances of this kind it is therefore desirable to use a starting box. The makers of the motor are prepared to furnish a cheap form of starting box which is operated very much the same as an ordinary direct-current starting box. The advantage to be gained from the use of this is very clearly

illustrated in Figure 5. It will here be seen that it is possible to start the motor under full load with a current approximating full load current.

As the combined power and lighting load on a given feeder begins to reach the capacity of the feeder it is sometimes very

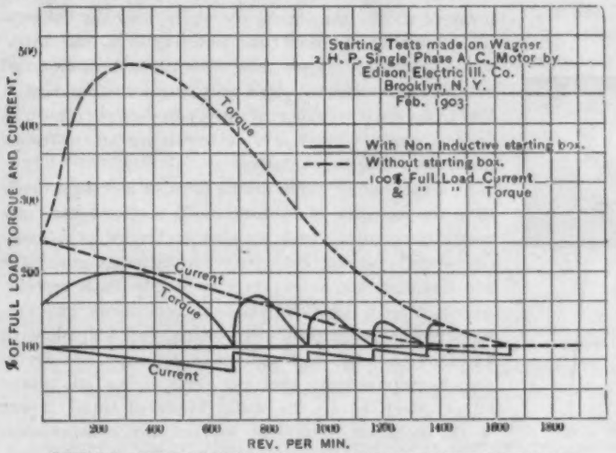

Starting Tests made on Wagner 2 H. P. Single Phase A. C. Motor by Edison Electric Ill. Co. Brooklyn, N. Y. Feb. 1903
With Non Inductive starting box.
Without starting box.
100% Full Load Current
" " Torque
Torque
Current
Torque
Current
% OF FULL LOAD TORQUE AND CURRENT.
REV. PER MIN.

FIGURE 5. STARTING TESTS MADE BY BROOKLYN EDISON COMPANY ON THREE HORSEPOWER WAGNER SINGLE-PHASE MOTOR

desirable, and in fact practically necessary, to install at the station some kind of a pressure regulator for this feeder. It is excellent engineering practice to use individual pressure regulators, capable of giving at least 10 per cent. regulation above or below the generator busbar voltage. These regulators are not expensive and are exceedingly useful.

Another consideration calling for careful attention is the frequency of the circuit. It is desirable to maintain, for good motor

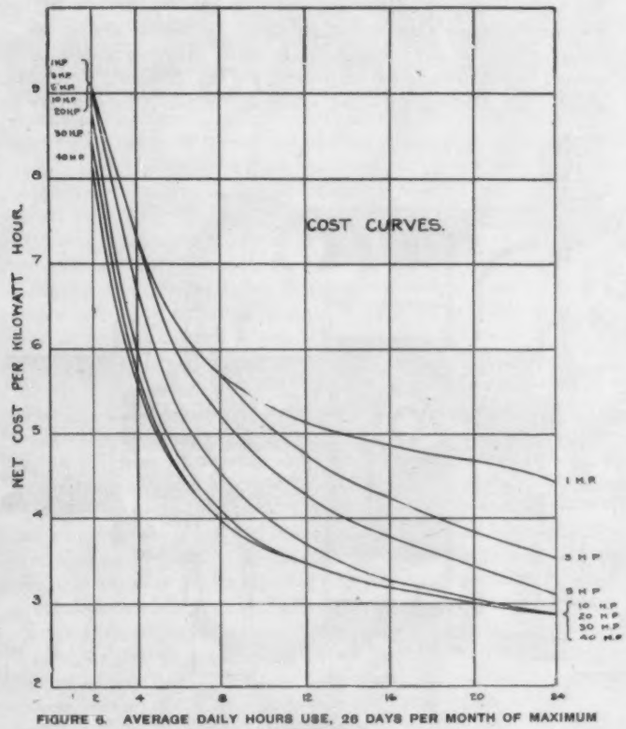


FIGURE 6. AVERAGE DAILY HOURS USE, 26 DAYS PER MONTH OF MAXIMUM HORSEPOWER

service, a uniform frequency, and every central station superintendent should be provided with a speed counter, so that he can determine the actual frequencies of the engine under full load. We have found instances where engine frequencies vary by as much as 10 or 12 per cent. between no load and full load, and, further, where engine speeds are not adjusted within this margin of the rated frequency of the machine. Our recommendation would be to always have the frequency adjusted to the standard, and then maintain this frequency constantly within 2 or 3 per cent. Any reasonably good engine will carry its load within these limits.

The feeder pressures should be regulated for the lighting service. If 110 or 112 volt lamps are used, and the pressure is kept up to this limit, for lamp load, motors will take care of themselves. It is safe to operate any alternating-current motor on a pressure of 10 to 15 per cent. above its rated pressure. This simply results in the motor having a little larger energy loss, as stated previously, and at the same time it increases its load capacity very materially.

Referring again to the curves of the Chicago Edison Company, please note how conspicuously uniform the motor load is, month in and month out. The largest variation from the normal load during the last year seems to be about 7 per cent. A manufacturing plant whose output did not vary more than this amount at any time throughout the year would be regarded as operating under magnificent conditions. This motor load, coming during that part of the day when the station capacity is largely available for it, may be taken at much lower rates than a station could afford to grant for lighting services. In fact, it is the practice of the majority of central stations to grant a sliding scale arrangement, depending upon the number of hours of service and the size of the motor. It may be of interest to this convention to illustrate the schedule of charges of one or two companies. Figure 6 is the schedule in force in Chicago at the present time.

The following table gives the schedule of rates at Peoria, Ill.

0 to	100	k. w. hrs.	consumed	during	1	mo.,	10c.	per	k. w.	hour.
101 "	200	"	"	"	1	"	9c.	"	"	"
201 "	300	"	"	"	1	"	8c.	"	"	"
301 "	400	"	"	"	1	"	7c.	"	"	"
401 "	500	"	"	"	1	"	6c.	"	"	"
501 "	700	"	"	"	1	"	5c.	"	"	"
701 "	1000	"	"	"	1	"	4c.	"	"	"
1001 "	1500	"	"	"	1	"	3.5c	"	"	"
1501 "	2000	"	"	"	1	"	3c.	"	"	"
Over	2000	"	"	"	1	"	2.8c	"	"	"

It is expressly agreed and understood that the above rates apply only to current supplied between 7 A. M. and 6 P. M., the company reserving the right to shut off current or charge 11 cents per kilowatt hour for current supplied during the hours from 6 P. M. to 7 A. M., and also on Sundays and legal holidays.

The following are the Cincinnati Gas and Electric Company's power rates:

The rate of charge of electricity consumed, as shown by the meter or meters installed by this company, shall be 10 cents for each 1000-watt hours, From this rate discounts shall be allowed for quantity consumed each month, as follows:

Discounts on power service—

On consumption	in	1	mo.	of	less	than	100,000	watt	hrs.,	10	per cent.
"	"	"	1	"	of	100,000	to	200,000	"	20	"
"	"	"	1	"	"	200,000	"	300,000	"	30	"
"	"	"	1	"	"	300,000	"	400,000	"	40	"
"	"	"	1	"	"	400,000	"	800,000	"	50	"
"	"	"	1	"	"	over	800,000		"	60	"

The company agrees to allow the consumer an additional discount of 5 per cent. for prompt payment only upon such bills as shall be paid at the company's office on or before the fifth day after their dates.

The rates will, of course, vary widely with the cost of fuel, but it is a well conceded principle that the basis of charge for lighting service is in no sense a criterion for motor service.

In concluding this paper, and for the benefit of those who are not familiar with the Wagner single-phase motors, a description of that motor may prove of interest.

A great amount of time and thought has been devoted to the production of a commercially successful single-phase motor. Early efforts to produce such a motor were broadly confined to

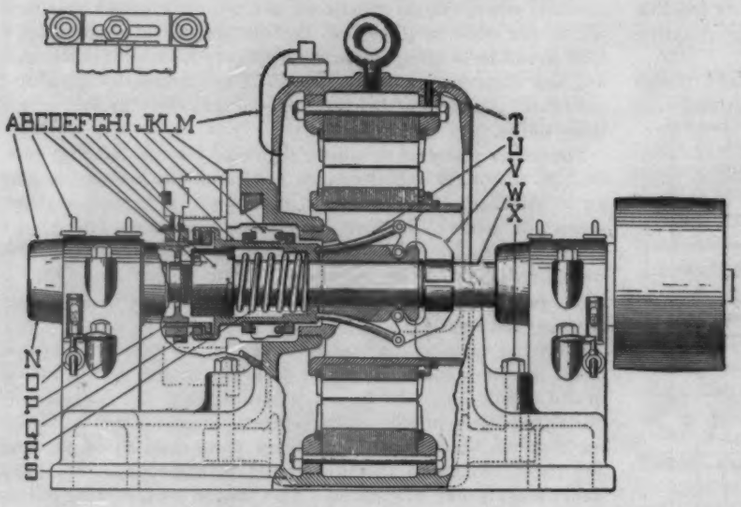


FIGURE 7. CROSS SECTION TYPE A MOTORS.

A—Pillow Block Cap.
B—Oil Cover.
C—Rocker Arm.
D—Spring Nut Key.
E—Spring Nut.
F—Adjustment Stud.
G—Brush Holder Spring.
H—Carbon Brush.
I—Spring Barrel.
J—Brush Holder.
K—Short Circuiting Ring.
L—Commutator.
M—Terminal Cable.
N—Pillow Block.
O—Oil Cock.
P—Rocker Arm Tube.
Q—Spring Barrel Ring.
R—Governor Spring.
S—Field Clamp.
T—Dowel Pin.
U—Governor Weight Pin.
V—Governor Weight.
W—Shaft.
X—Strap Bolt.

two characteristic types—the synchronous motor and, second, the direct-current motor, slightly modified to operate on alternating current. These efforts proved futile, and no large degree of success in the production of a single-phase motor was obtained until the present form of induction motor, built by the Wagner Electric Manufacturing Company, was placed upon the market. The motor consists essentially of primary or stationary element, commonly referred to as the "field," and a secondary or revolving element, commonly referred to as the "armature." These elements are entirely independent of each other. The current from the source of supply is fed into the field, and this induces all current set up in the armature windings. In general terms, the armature may be said to be of the well-known direct-current form, a progressive winding being connected to a radial commutator in the usual direct-current armature fashion. Brushes are provided which, under usual circumstances, are short-circuits through the rocker arm carrying them. In addition to these brushes, there is placed within the annular opening of the commutator a short-circuiting device, centrifugally controlled, the purpose of this device being to completely short-circuit the commutator, and, through the commutator, the armature windings, when the armature has attained a predetermined speed of rotation. The motor is designed to operate in two distinct ways—first, with one combination of elements at starting, and, second, with another combination of elements in the running condition. In starting, the induced currents of the armature windings are given a directional control through the brushes, which results in the rapid acceleration of speed, up to what may be termed the normal operating speed. At this point the centrifugal device comes into play, forcing the short-circuiting links into the annular commutator opening. Simultaneously the brushes are removed from the commutator, and thereafter the armature revolves, performing its function in a manner quite similar to the ordinary polyphase motor.

The motor is shown in cross-section in Figures 7 and 8.

The perfection of mechanical and electrical design of this motor is evidenced by its successful operation over a period of a number of years on almost all the leading central station systems of distribution. That the commutator arrangement meets satisfactorily the requirements of the service is evidenced by the fact that the Wagner Company has been building this form of motor for almost six years, and has not supplied up to the present time more than a half-dozen renewal commutators, and this limited number of commutators was supplied to a single customer, who had installed a number of thirty-horsepower motors to perform a special service involving an enormous number of stoppages daily.

At a number of conventions inquiry has been made as to the number of motors small stations can successfully operate. Instances are on record as follows: One station having a seventy-five-kilowatt generator has installed 100 horsepower in single-phase motors. Another with 180 kilowatts in generators has 140-horsepower in single-phase motors, and a third, with an eighty-five-kilowatt generator capacity, has forty-five horsepower in motors. This form of motor adapts itself to all the usual kinds of small power work, such as pumping service, air compressors, printing presses, blowers and small factory driving, coffee mills, belted elevators, storage battery charging through the medium of motor generator sets, etc. The type of single-phase motor built by the Wagner Electric Manufacturing Company at the present moment is limited in application in only two ways—first, in handling of work requiring a variation of speed, and, second, in the handling of work calling for a great number of starts daily.

Inquiry is also frequently made as to the vital differences between the single phase motors, built by the Wagner Electric Manufacturing Company, and forms advocated by other makers. The most important difference may be said to consist in the Wagner Company's method of starting. So far as the writer is aware, there is no commercial form of starting single-phase motors, aside from that employed by the Wagner Company, which will develop full-load starting torque. Other forms of

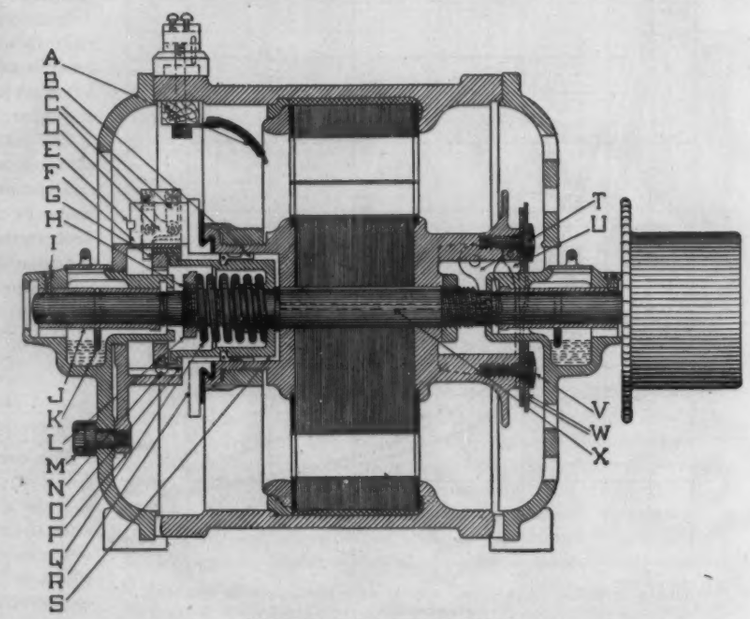


FIGURE 8. CROSS SECTION TYPE B.

A—Terminal Cable.
B—Short Circuiting Ring.
C—Knock-off Links.
D—Knock-off Piece.
E—Brush Holder Spring.
F—Carbon Brush.
G—Rocker Arm Ring.
H—Spring Nut Screw.
I—Bearing Screw.
J—Bearing.
K—Oil Ring.
L—Spring Nut.
M—Reversing Screw.
N—Brush Holder Ring Screw.
O—Brush Holder Ring.
P—Brush Holder.
Q—Governor Spring.
R—Commutator.
S—Spring Barrel.
T—Bell Crank.
U—Governor Weight Link.
V—Governor Weight Stud.
W—Governor Weight.
X—Spring Barrel Pin.

single-phase motors are modifications of polyphase designs, and these modifications do not develop with reasonable starting current a starting torque much in excess of 30 to 50 per cent. of full load torque. Auxiliary devices are therefore employed for the purpose of applying the load to the motor gradually, after the armature has attained full speed. On the reliability of these auxiliary devices depends the success of operation of the motor. The Wagner Company's motor, as distinguished from these forms which are modified polyphase motors, may be properly said to correspond to the standard direct current in that the Wagner motor will do the work, both in starting and in running, of a direct-current motor, and in this respect is unique and stands alone as a single-phase power motor.

PUBLICATIONS.

"SUPLEE'S MECHANICAL ENGINEERS REFERENCE BOOK." Published by the J. B. Lippincott Company, Philadelphia. Bound in red limp leather, with gold lettering, round corners and gilt edges. Price, $5.00; with patent thumb index, $5.50.

The usefulness of a technical work of this nature depends upon three things: the authority of the writer, its comprehensive grasp of the whole field of mechanical engineering, and its arrangement with a view to ready and accurate reference. These are pre-eminently features of this volume.

Mr. Suplee is a member of the American Society of Mechanical Engineers, a member of the Franklin Institute, and editor of two important mechanical periodicals, and both by experience and by acquaintance with the literature on the subject he is competent to prepare a hand-book of the first rank both as to reliability and practical usefulness. Moreover, he has been able to avoid those weaknesses into which a technical writer is often betrayed by his personal interest in one phase of the subject or by his partiality for certain methods or theories. He is possessed as well of a singularly clear, explicit and illuminative style of writing, and he has expressed himself with rare lucidity and conciseness. In its breadth of view and its grasp of detail the new "Mechanical Engineer's Reference Book" combines the advantages of former works with the most recent information which necessarily is found only in a volume of immediate publication. It is especially to be noted that it deals with certain phases of the subject not treated in any other general work, notably in information of value to the shop manager and in the details of cost and results of employing the methods and plans described or recommended in this volume.

Among the new features in the book which deserve special notice are those included in the chapter on Machine Design, a most important subject, which is treated very fully and in a way to make it especially useful to the draughtsman by reason of its illustrations of machinery and of parts of machines, and by the necessary formulas for securing proportions, strength, etc. The designer and engineer will find these pages a treasure house of up-to-date information about gearing, pulleys and their speed, bearings, boilers and their accessories, cranes and other mechanical appliances, together with the problems which they involve, and of the other various forms and mechanisms by which power is transmitted or developed. The designer of power plants will be particularly grateful to Mr. Suplee for the large amount of space devoted to this and cognate subjects embracing the most improved plans and methods sanctioned by recent engineering experience. Electricity, likewise, has a large place in the book, including the driving of machines by electric motors and the choice and use of motors, modes of electrical transmission, description of electrical machinery and its various applications.

In the matter of arrangement it need only be said that this has been with Mr. Suplee a question of the first importance, realizing as he does that the usefulness of any reference book depends largely upon the ease with which it may be consulted and the readiness with which a particular line of investigation may be followed from page to page.

An idea of the range of the work may best be had from mention of the main heads under which Mr. Suplee has considered engineering problems, viz., Mathematics, Mechanics, Materials of Engineering, Strength of Materials, Machine Design, Heat, Air, Water, Fuel, Steam, Steam Boilers, Steam Engines, Internal Combustion Motors, Electric Power, The Cost of Power and Works Management, etc.

The make up of the volume and the typography, paper and excellence of its printing and binding are worthy of special commendation.

UNITED STATES CIVIL SERVICE EXAMINATIONS.

[No. 262.]

HEATING AND VENTILATING DRAFTSMAN, SUPERVISING ARCHITECT'S OFFICE, TREASURY DEPARTMENT.

The United States Civil Service Commission announces an examination on April 19, 20, 1904, at the places mentioned in the accompanying list, to secure eligibles from which to make certification to fill three vacancies in the position of heating and ventilating draftsman, office of the Supervising Architect, Treasury Department, at $1200 per annum, and other similar vacancies as they may occur.

The examination will consist of the subjects mentioned below, which will be weighted as follows:

Subjects.	Weights.
1. Mathematics (comprising arithmetic, geometry—plane and solid, algebra to quadratics, plane trigonometry, mensuration)	10
2. Practical questions in heating and ventilating (involving a competent knowledge of the subject of heating and ventilation of buildings, both theoretical and practical)	30
3. Drawing and design (involving ability to design and draw plans, etc., for the heating and ventilating plants of modern public buildings)	30
4. Educational training and experience	30
Total	100

Age limit, 20 years or over.

The examination is open to all citizens of the United States who comply with the requirements. Competitors will be rated without regard to any consideration other than the qualifications shown in their examination papers, and eligibles will be certified strictly in accordance with the civil service laws and rules.

Persons who desire to compete should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the local board of examiners, for application Form 1312, which should be properly executed and filed with the Commission at Washington. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

Persons who are unable to file their formal applications and who notify the Commission of this fact, either by letter or telegram, with the request that they be permitted to take the examination, will be examined, subject to the subsequent filing of their applications, provided their requests are received at the Commission in sufficient time to ship examination papers.

Issued March 2, 1904.

DECEASED.

George Frederick Gilbert died of typhoid fever at St. Mary's Hospital, Rochester, N. Y., on January 12th, aged 42 years. Mr. Gilbert was a resident of Lakeville, Livingston County, N. Y. For several years he was engaged in the produce business, and was postmaster for four years under Cleveland. In 1896 he became connected with the H. W. Johns-Manville Company, New York, and was their general sales agent for northern and western New York. He also represented the company in connection with work for the State government. In 1860 he married Miss Mary Halleran, at Rochester, N. Y., who, with his mother and a brother, survives him.

The Journal of ELECTRICITY POWER and GAS
DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

PUBLISHED MONTHLY BY
The Journal of Electricity Publishing Company
Room 532, Rialto Building, San Francisco, Cal.
Telephone Main 1264.

Official Organ of the Pacific Coast Electric Transmission Association.

Yearly subscription: Domestic, $2.00; Foreign, $2.50; Single Copies, 25 cents.
Subscriptions can not be begun with back numbers.
Manuscripts submitted must be accompanied by postage to insure return.

ADDRESS ALL COMMUNICATIONS AND MAKE ALL REMITTANCES PAYABLE TO THE JOURNAL OF ELECTRICITY PUBLISHING COMPANY.

This paper is a member of the National Trade Press Association.

Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as *The Electrical Journal*, July, 1895. Entry changed to *The Journal of Electricity*, September, 1895.

VOLUME XIV APRIL, 1904 NUMBER 4.

EDITORIAL.

IN THE MATTER OF STEAM BOILERS.

The keen rivalry which has existed in southern California for years between the manufacturers of various types of water tube boilers for the control of the patronage of the great electric corporations of that section, has resulted in a distinct benefaction to the science of steam engineering, in that it has brought about a series of tests which from standpoints of painstaking thoroughness and conscientious execution must go into the classics of mechanics. The commercial importance of the test, in that it establishes the superiority of one particular build of boiler over that of another manufacture, is of slight consequence compared with the fact that steam engineers are now, for the first time, placed in possession of accurate data relative to the performances of two distinct makes of water tube boilers, especially in matters pertaining to the efficiency and capacity of each, and the quality of steam which they respectively produce when burning oil. Textbooks teem with boiler tests under coal burning in bare, cold figures, but nowhere has there been presented any publication giving such minute detail of preparation, procedure and performance as that which is embodied in the communications which form the leading article of the present issue of THE JOURNAL.

Intelligent progressiveness has ever been the watchword of the Pacific Light and Power Company, which knows full well that efficiency of apparatus is as vital to its productiveness as is fertility of soil to the prosperity of the orchardist. Being about to place a large order for steam boilers, and as perplexity as to the relative merits of the two leading types evidently existed, it was determined, along last fall, to arrange for a boiler test that would set at rest, for once and for all, each and every question of doubt. No effort that would disclose a pertinent fact was left unexhausted, and now, thanks to a spirit of public spiritedness too seldom met, the far reaching results are given to the engineering world without reservation.

There were three parties to the test, namely, the Pacific Light and Power Company, the Babcock & Wilcox Co. and the Stirling Company, the two latter being the respective manufacturers of the well known Babcock & Wilcox and the Stirling water tube boilers. All preliminary features were carefully laid down in duly signed articles of agreement, in accordance with which a test committee was appointed consisting of E. H. Peabody, representing the Babcock & Wilcox Co., and H. M. Boon, representing the Stirling Company, these two appointing Professor C. L. Cory, of the University of California, to act as third committeeman and umpire. Probably no better selection could have been made, for each is an engineer of the highest standing. Their report is of the utmost thoroughness, for it covers every detail from the initial settings of the boilers and their respective burners on down through every feature of each test to the final inspection and discussion of the condition of the boilers after the strenuous service to which they had been subjected. Four ten-hour tests were made of each boiler, the period of test extending at intervals from December 4th to December 21st, last, inclusive, these tests being, first, at a rate of evaporation of from three and one-half to four pounds of water per hour from each square foot of heating surface, the second at the rate of four and one-half pounds, the third at five and three-quarters pounds, and the fourth and last test to be for the maximum capacity of evaporation which it is possible to obtain. Incidentally, the quality of steam produced, the percentage of entrained moisture, the temperature of escaping gases, the amount of steam used by the oil burners, the performance of oil burners, the evaporation per pound of oil from and at 212 degrees Fahrenheit, the heat values of the Whittier and the mixture of Whittier and Los Angeles oils used, and the changes which occurred in the condition of the boilers during the successive stages of the test were all brought out in surpassing fullness.

It cannot be gainsaid, however, but that the chief interest from the commercial rather than the engineering point of view will center in the decided advantage which the test shows that the Babcock & Wilcox boiler possesses over the Stirling boiler in every count. For instance, in the matter of efficiency, the percentage of gain reached in the efficiency of the Babcock & Wilcox boiler over that of the Stirling in the four tests was respectively 4.93 per cent., 5.10 per cent., 7.18 per cent. and 2.97 per cent.; the percentage of moisture in the steam produced by the Babcock & Wilcox boiler exceeded that from the Stirling boiler in the four tests by 0.35 per cent., 0.38 per cent., 0.52 per cent. and 0.55 per cent. respectively, and,

similarly, the temperature of escaping gases from the Babcock & Wilcox boiler were lower by 16 degrees, 53 degrees, 81 degrees and 98 degrees Fahrenheit in the respective tests than that from the Stirling boiler. The evaporation per pound of oil from and at 212 degrees Fahrenheit varied from 13 85 pounds in the Stirling boiler during the fourth test to 16.01 pounds for the Babcock & Wilcox boiler during the first test, and the increased evaporation for the latter boiler over the former during each of the four tests were respectively 0.70 pounds. 0.79 pounds, 0.96 pounds and 0.35 pounds, while the percentage of steam used by the burners ranged from 1.96 per cent. to 3.42 per cent., both occurring during the first test, and the amounts given being for the Babcock & Wilcox and the Stirling boilers respectively. The minimum and maximum efficiencies attained ranged from 71.50 per cent. for the Stirling boiler during the last test to 83.06 per cent. for the Babcock & Wilcox boiler during the first test; but as the last test was made to show the maximum working capacity that could be reached under the existing conditions without regard to efficiency, no note should be taken of the minimum efficiency of 71.50 per cent. as given. Applying this correction, the minimum becomes 74.05 per cent. for the Stirling boiler in the third test.

THE COMING CONVENTIONS.

With the advent of spring the engineers of the Far West who look to fraternization bethink themselves of the approaching conventions of the Pacific Coast Electric Transmission Association and of the Pacific Coast Gas Association, which are held in June and July respectively. To be exact, the Transmission Convention, which marks the eighth year of the life of the Association, is fixed by the Constitution to be held beginning with the third Tuesday of June, that is on June 21st, while similarly the Twelfth Annual Meeting of the Gas Association begins on July 20, lasting three days.

As yet no official announcements have been issued concerning the subject matter that is to be discussed at these conventions, nor is it known that the executive officers of either association have reached any definite formulation of the programmes which are to be followed. That the important preliminaries of this nature will not escape careful attention goes without saying, and it is safe to predict that the coming conventions will fully uphold the high standards of excellence which the previous gatherings have established.

*

From a business standpoint, probably the most important matter which is to come before the Transmission Association is that relative to its suggested reorganization. That the Transmission Association is cumberous and bulky is patent to all, and that necessity exists for its reorganization on lines of greater flexibility and utility was recognized during the last convention, when a special committee of three, consisting of Messrs. Hutton, Ray and Van Norden, was appointed to formulate and submit a plan of reorganization that should widen the scope of the Association so as to gather within its ranks the entire power and lighting industry of the Pacific Coast without specializing that members shall be engaged in electrical transmission. It has been suggested, too, that members shall consist of individuals rather than corporations, and that the matter of dues shall be revised on such a basis that the exchequer shall not show a deficit at the end of each fiscal year. This does not necessarily mean an increase of dues; rather does it signify that the qualifications for membership shall be liberalized so that any firm, individual, company or concern which may be engaged in the lighting and power business, without regard to any transmission feature, shall be eligible to membership, for only through an enhanced interest and increased membership may the ends, aims and finances of the Association be placed on a satisfactory plane.

The sturdy condition of the Gas Association may well serve as a pattern for the reorganization committee of the Transmission Association to model after, for it is a solid, sound, prosperous, conservative and highly valuable organization. Indeed its usefulness to its members is immeasurably great, and the secret of its success rests in the fact that its members work as a unit to achieve a common end, it is conducted on hardy business principles, and, therefore, it is not solely dependent upon the energy and enthusiasm of any one man to carry it through.

The truth is that if the Transmission Association would emulate the example of the Gas Association and maintain an active career of usefulness it must wake up.

THE LAMP SITUATION.

To the minds of the lamp consuming public it would seem that the time has long since lapsed when there should be any disquietude in the incandescent electric lamp market, or even in the conditions surrounding the supply of lamps, for with all the litigation which has fortunately long since been known only to memory, and with the consolidations and changes which have marked the later years of the business, it appears to be possibly unthinkable that aught else but equanimity should mark the course of so well established an industry.

But there are rumors of unrest on every hand. Whether they anticipate a giant consolidation of the principal lamp manufacturers, or whether the holders of patents believed to be vital propose to seine the sea for the small fry, or whether the industry is to be directed into some unheralded domain, is all a mystery to those of the outer cult to whom it is not given to know the inner workings of the holy temple of financial incubation.

Whatever may happen, consumers of lamps may rest secure in the knowledge of the fact that two fundamental features of the lamp business will always remain as cardinal virtues to bring about its redemption: First, the higher the price paid for the lamp the better the lamp; second, if the price becomes unreasonably high, outside capital stands ever ready to enter the manufacturing field to reap its part of the harvest.

CARBONETS.

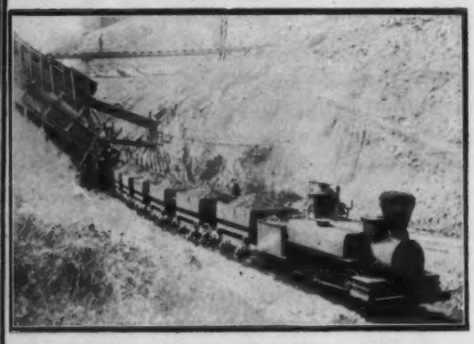
WE present in this issue drawings of a new method of making artificial fuel, designed and patented by Charles R. Allen, San Francisco, to be known as "Carbonets." The plan may be likened to that used in Nature's laboratory, viz., crushing, drying, distilling, heating and binding.

The system seems to proceed in a diametrically opposite direction from that usually adopted in briquetting fuel, in that it granulates, but does not powder, shapes, but does not subject the blocks to a heavy pressure. The coal and binder are treated so intimately that the cooling of the finished product, added to the pressure exerted in shaping, gives the required solidity to stand exposure and transportation.

The advantage of this method is, that when the fire attacks these blocks they will act much like a hard bituminous coal. The blocks will split open and form a coke, releasing the gases only so fast as the fire will consume them, thus being a smokeless coal, suitable for all purposes where anthracite coal is now thought to be indispensable.

SHAFT OF PITTSBURG COAL MINES 600 FEET DEEP

CAGE



COAL BUNKERS AND CARS PITTSBURG RAILROAD CO.

This method of mixing coal and pitch, under a high degree of temperature, gives to an ordinary lignite the qualities of a bituminous coal.

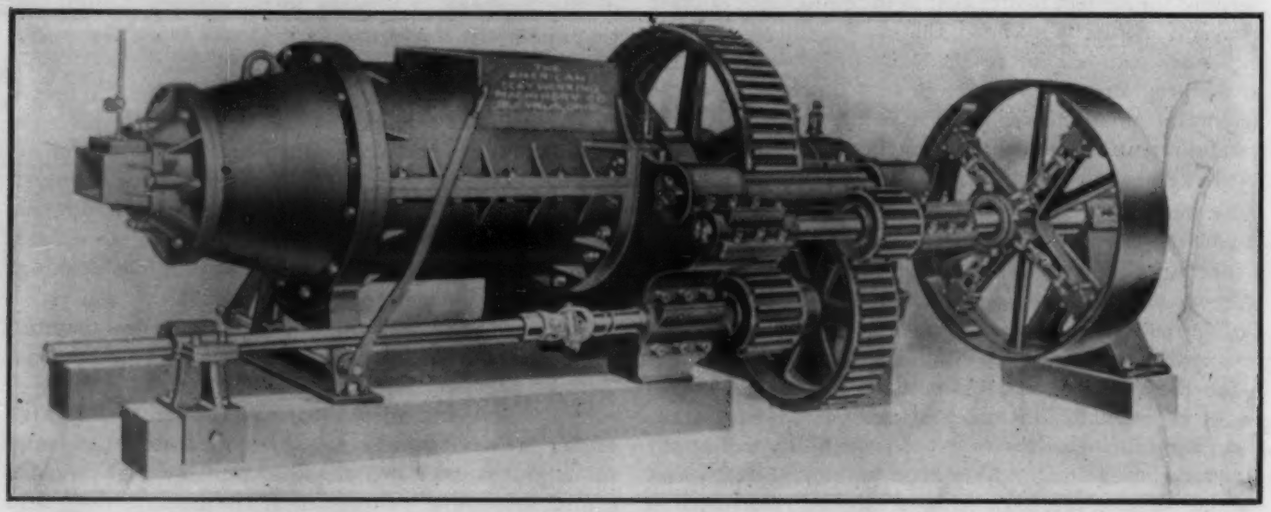
After passing through a granulator, dryer and a seal, the combining takes place, passing the coal and binder together through six twelve foot retorts, a seal, then to a shaping tube, from which a new cutting device separates the streams of fuel into cubes of about two and one-half inches, care being taken to reduce the temperatures gradually from one machine to the next, resulting in a product containing 93 per cent. of coal and 7 per cent. binder. The process is automatic from the dropping of the coal through the bottom doors of the coal cars which bring the coal from the mine to the time the carbonets are drawn from the bunkers into the cars of the railroad companies for distribution.

The manufacture of artificial fuel, which has reached vast proportions in Europe, is now attracting great attention in this country; but it would be folly to expect our people to take kindly to a fuel simply because it is cheap, as the poorer class of Europe do. Americans always demand a good article. Therefore, in order to successfully market an artificial fuel all of the most favorable conditions must obtain, such as a first-class coal mine, an up-to-date process, shipping facilities, nearness to market, etc., all of which advantages are possessed by this company to a marked degree, having its own coal mines, with upward of three million tons of first-class coal, its own railroad, fully equipped, wharves with thirty feet of water, bunkers to load into Southern Pacific, Santa Fe or Pittsburg cars, steamers, vessels, etc.

This plan has been thoroughly studied by several of the most competent experts, civil engineers, and the general opinion is, that it is novel and ingenious, and is likely to be a turning point in the matter of making artificial fuel.

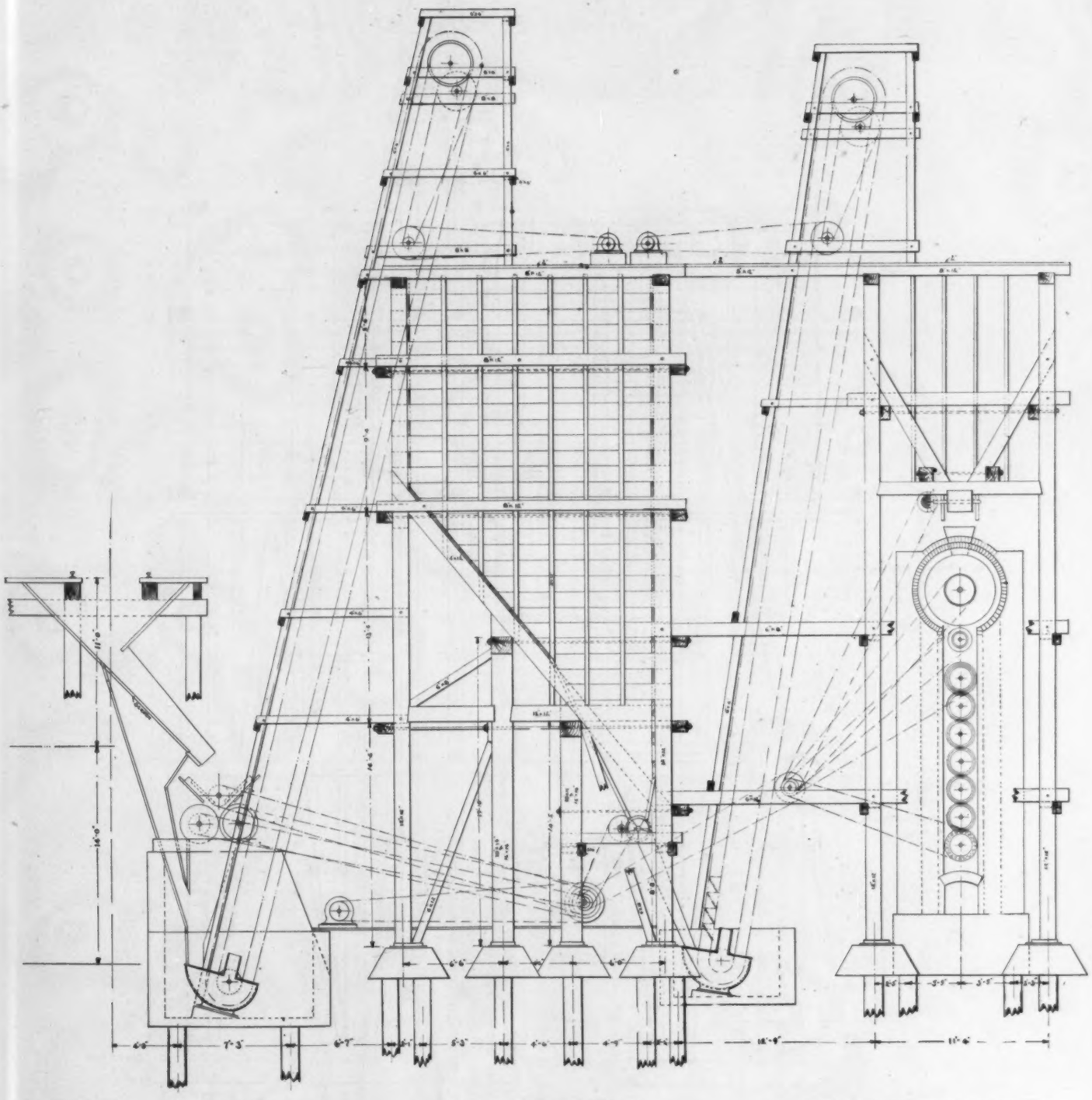
The machinery is nearly all completed, and within a few weeks the plant will be in operation.

Apologies are offered California coal dealers for submitting this partial description; but something was promised before now, and rather than wait for complete plans we submit these sketches. While they are not what we would like to show, they give a good general idea of all but the beginning and ending.

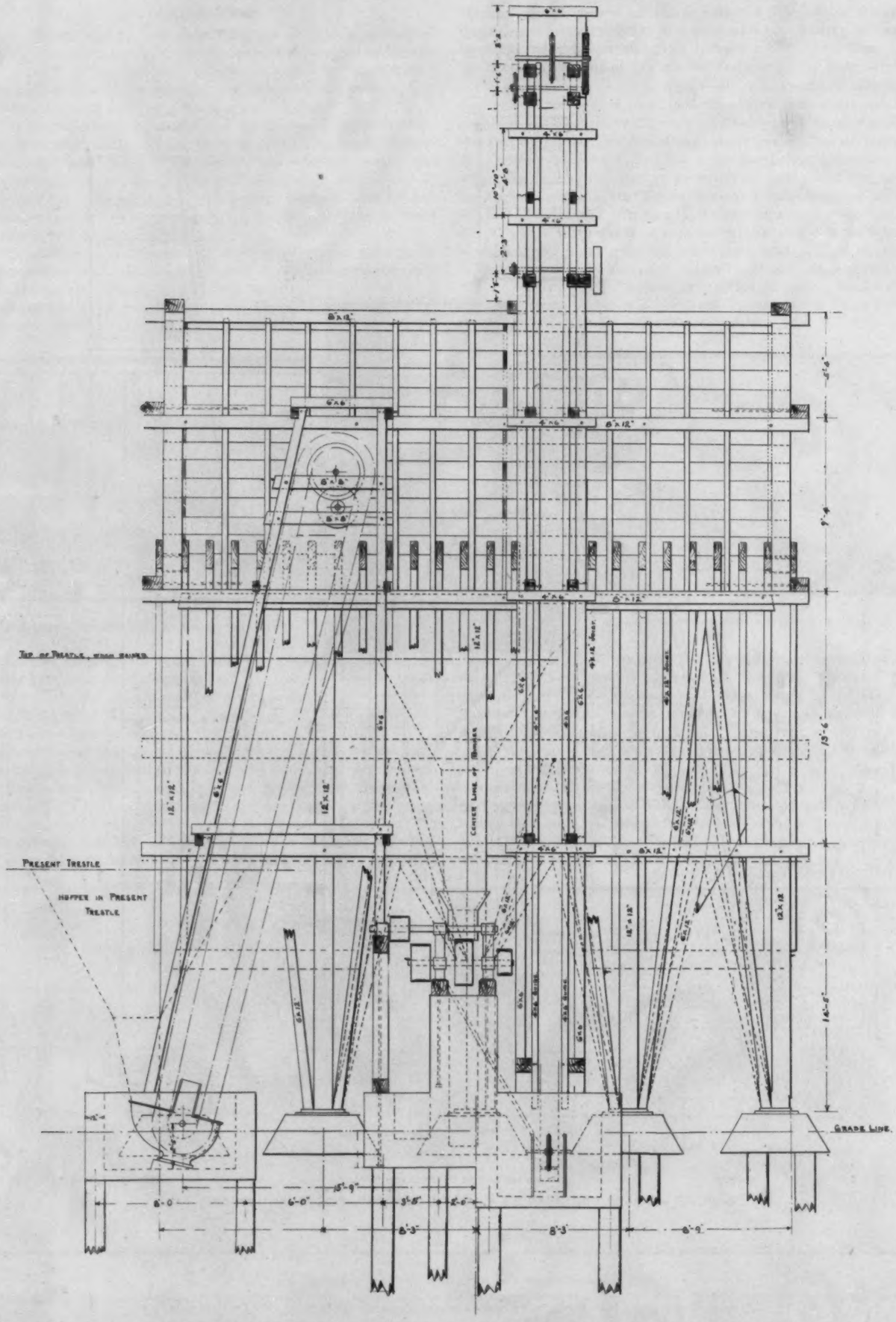


SPECIAL GIANT AUGUR MACHINE USED IH MAKING CARBONETS

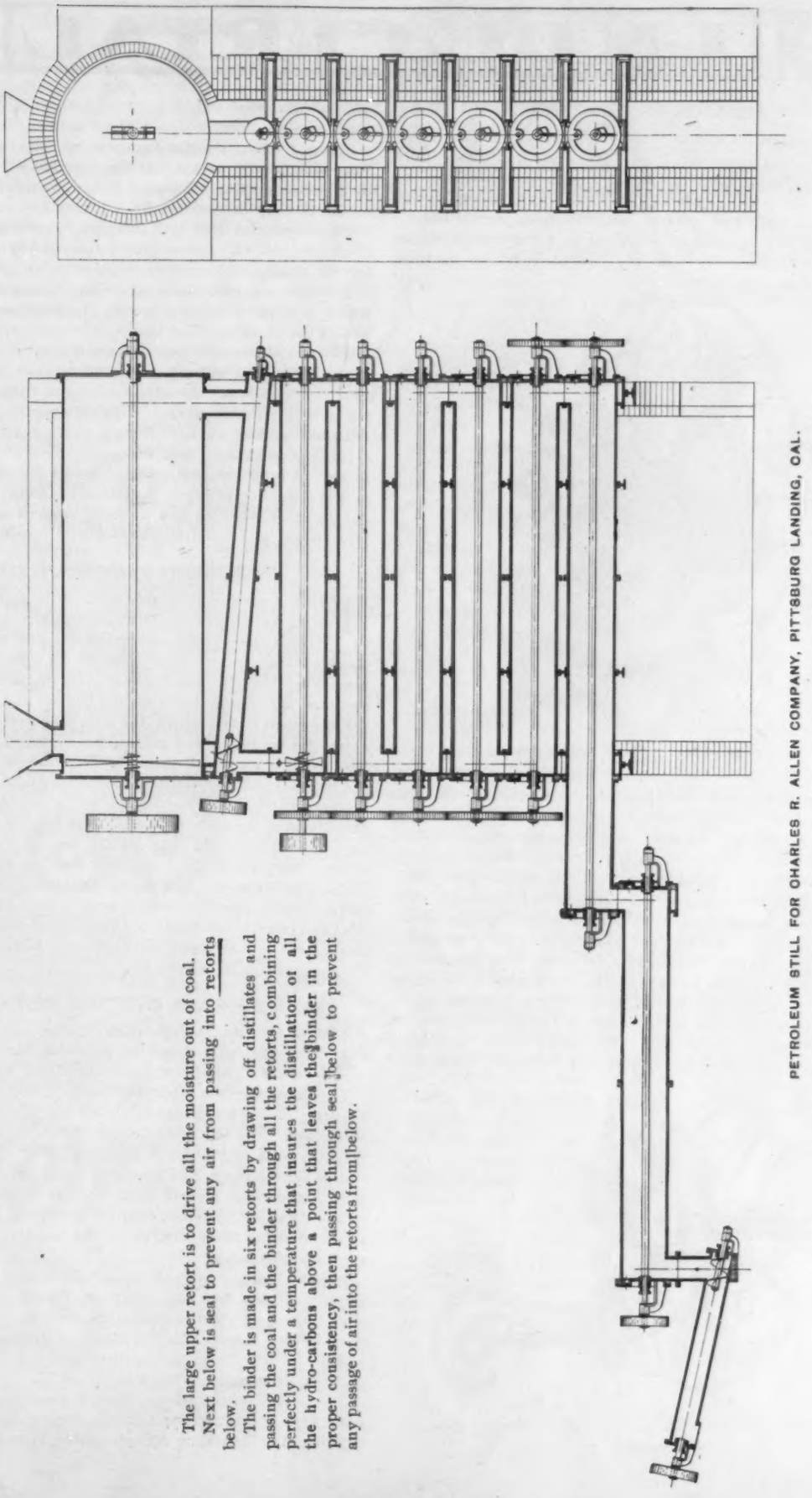
After passing four streams of two and one-half inches through nozzle of press the carbonets are conveyed 300 feet to coal bunkers, from which cars are loaded. These sketches leave out bunkers and conveyors from wharf and conveyors and bunkers from press.



PLAN OF BUNKERS FOR CHARLES R. ALLEN COMPANY, PITTSBURG LANDING, CAL.



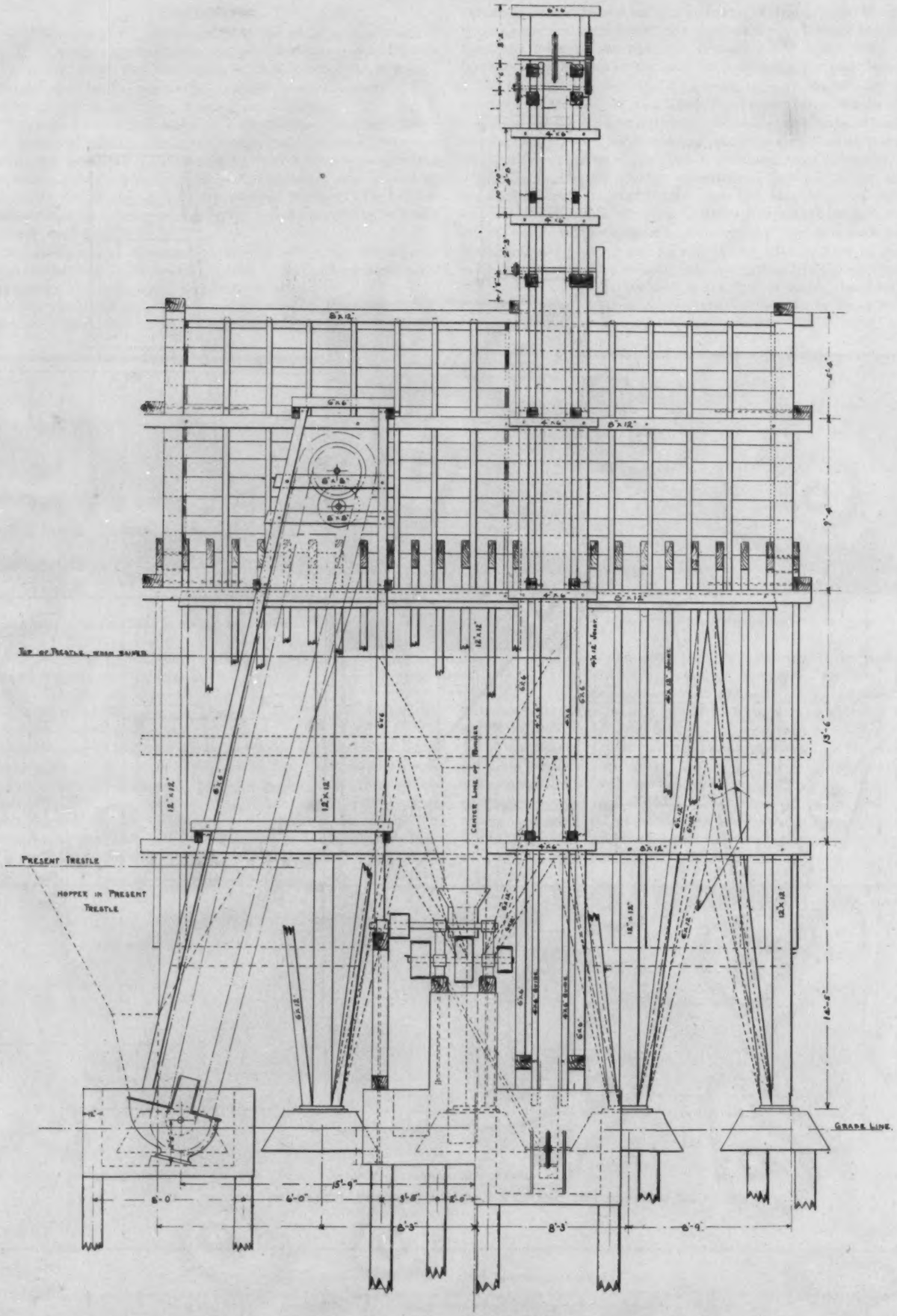
FRONT ELEVATION OF BUNKERS FOR CHARLES R. ALLEN COMPANY, PITTSBURG LANDING, CAL.



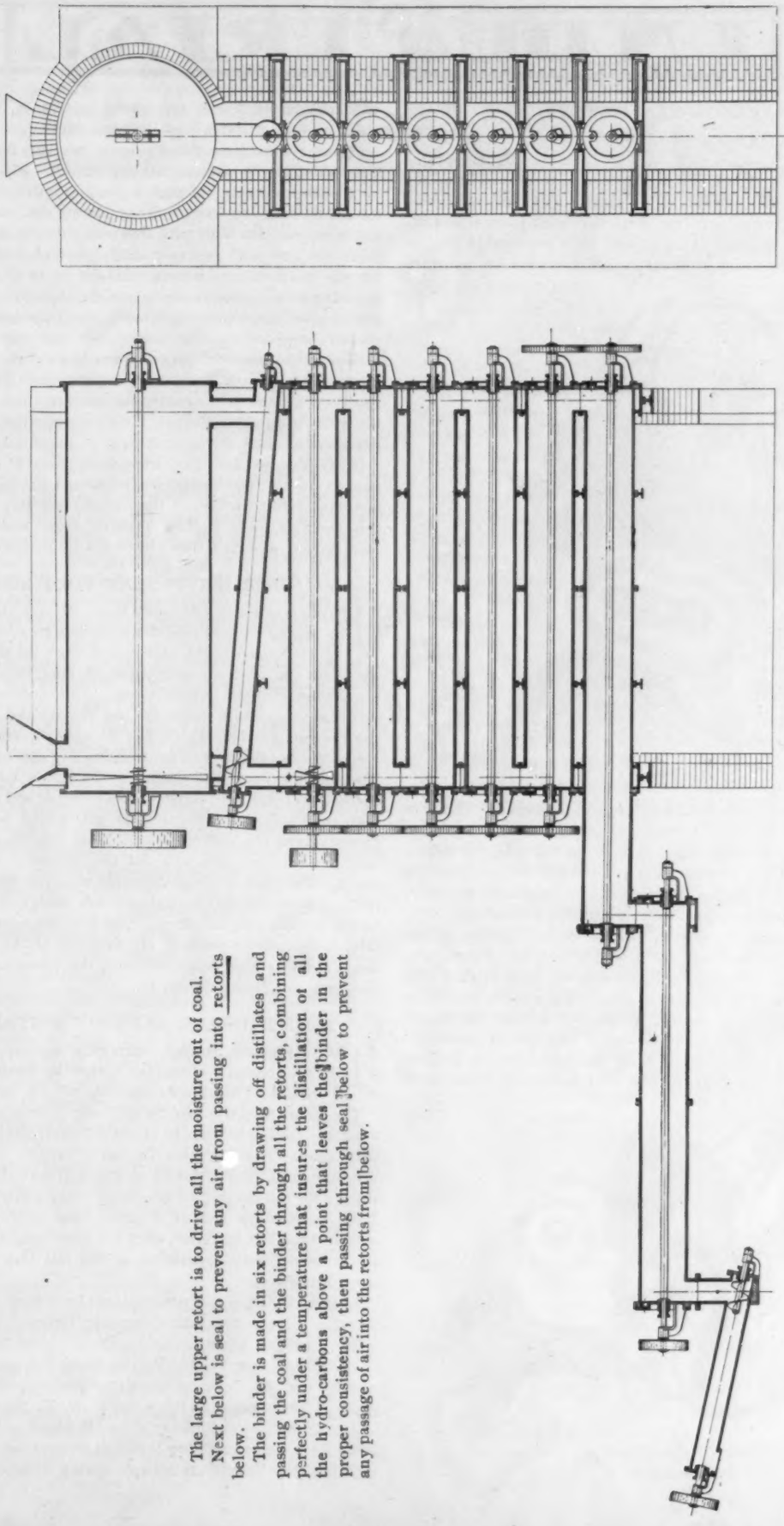
PETROLEUM STILL FOR CHARLES R. ALLEN COMPANY, PITTSBURG LANDING, CAL.

The large upper retort is to drive all the moisture out of coal. Next below is seal to prevent any air from passing into retorts below.

The binder is made in six retorts by drawing off distillates and passing the coal and the binder through all the retorts, combining perfectly under a temperature that insures the distillation of all the hydro-carbons above a point that leaves the binder in the proper consistency, then passing through seal below to prevent any passage of air into the retorts from below.



FRONT ELEVATION OF BUNKERS FOR CHARLES R. ALLEN COMPANY, PITTSBURG LANDING, CAL.



PETROLEUM STILL FOR CHARLES R. ALLEN COMPANY, PITTSBURG LANDING, CAL.

The large upper retort is to drive all the moisture out of coal.

Next below is seal to prevent any air from passing into retorts below.

The binder is made in six retorts by drawing off distillates and passing the coal and the binder through all the retorts, combining perfectly under a temperature that insures the distillation of all the hydro-carbons above a point that leaves the binder in the proper consistency, then passing through seal below to prevent any passage of air into the retorts from below.

INDUSTRIAL

PARAGON FAN MOTORS.

THE Paragon fan motors, built by the General Incandescent Arc Light Company, New York, remain fundamentally unchanged. The machines have been improved in minor details, but the general design is the same. The field magnet is a single-piece casting of soft iron, with the front journal box integral. The rear bearing is contained in a removable cap, as indicated by Figure 1, the removal of which leaves an aperture

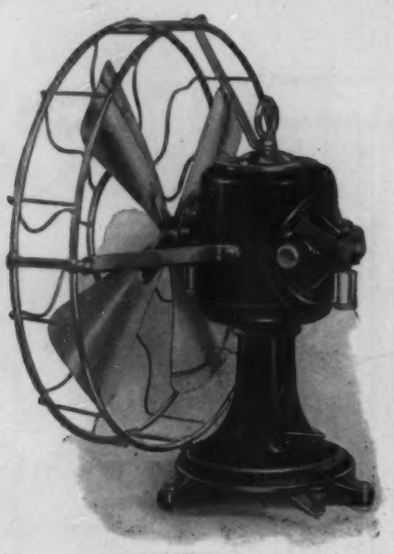


FIGURE 1

large enough to withdraw the armature and field coils. The field magnet coils are machine wound, covered with two layers of linen tape, dipped in insulating varnish and thoroughly baked. The armature is of the slotted-drum type, hand wound, and the complete armature is dipped and baked. As shown by Figure 1, the brush holders are mounted in the removable journal cap. The brushes are rectangular carbons, fed by helical springs in the usual manner. The bearings are self-aligning, have phosphor-bronze sleeves, and are lubricated by under-fed wick oilers in the standard machine. The company also builds what is known as the "Paragon Black" fan motor, which differs from the standard machine only in point of finish and in the use of grease instead of oil cups for lubrication. The standard motor is finished in plain black enamel, with dipped and lacquered brass work and an enameled iron fan guard, instead of the polished brass guard used on the standard Paragon motor.

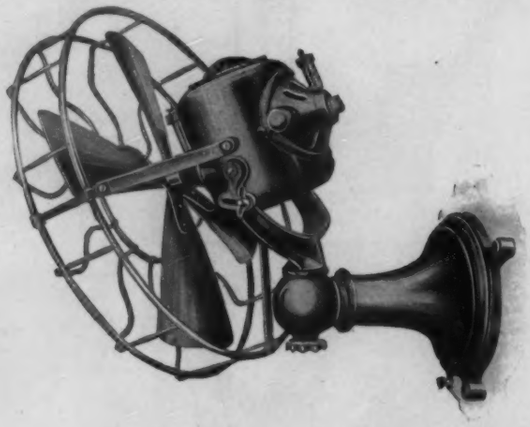


FIGURE 2

Figure 2 illustrates the Paragon bracket form of mounting, from which it will be seen that the trunnion adjustment is limited by a stud projecting through a slot in the trunnion arm, and the motor is held in position by a thumb nut on this stud. The machines are also built with trunnion form of mounting. All of them are built with twelve-inch and sixteen-inch fans and wound for the usual direct-current voltages up to 250 volts. They are provided with enamel insulated resistances and regulating switches which give three running speeds, the resistance being mounted within the pedestal. The twelve-inch machines run at 1700 revolutions per minute and require from thirty-five to forty-five watts, according to the voltage. The sixteen-inch fan motors run at 1500 revolutions per minute and require from sixty to seventy watts, according to voltage. This data applies to both the standard and the Black Paragon fans.

In addition to their San Francisco office at 69-75 New Montgomery street, the General Incandescent Arc Light Company are now maintaining offices in the Pioneer building at Seattle and in the Douglas building Los Angeles, from where any additional information and bulletins will be gladly furnished.

THE NIXON STAY BOLT SLEEVE.

THIS is not a flexible stay bolt. It is a sleeve which is designed to give flexibility to the stay bolt by dispensing with the abrupt and sharp edge of the heavy outside sheet in the past so destructive to stay bolts, as they nearly always break at the outside sheet. This breakage is due to the fact that the outside sheets are the heavier and will not yield to the enormous strain which the bolt is subjected to while undergoing the expansion and contraction so destructive to stay bolts. The sleeve is made bell-shape on the inside edge, thus allowing the bolt to bend with considerable freedom and giving it a flexible feature which is impossible to get where bolts are screwed directly into the outside sheet. The sleeves can be made of any desired size and will fill the largest hole in the outside sheet. They are made of desirable material which has stood the test. The Nixon stay bolt sleeve was designed to help men out of the broken stay bolt trouble, and it may be wise to give it a trial and convince yourself of the truth of the claims which are made for it by the manufacturers, the American Balance Valve Company, of Jersey Shore, Pa.

SOME STORAGE BATTERY INSTALLATIONS.

THE Electric Storage Battery Company, of Philadelphia, have recently closed the following contracts for batteries of the "Chloride Accumulators" for lighting and power:

The Union Electric Light and Power Company, St. Louis, Mo., a battery having a capacity of 462 kilowatt-hours in their exciter substation. The St. Louis Transit Company will have installed fifty-five cells of "Chloride Accumulators" in their new substation for the purpose of operating time switches. The Worlds Fair Automobile Transit Company has given an order for 100 sets of "Exide" batteries, each set consisting of forty-four cells, to be used for the operation of the bus line which will be in service at the fair.

Isolated lighting and power plants have been contracted for by the Union Trust Building Company, Detroit, Mich.; Morton F. Plant, Groton, Conn.; Abenaque Machine Works, Abenaque, Westminster County, N. Y.; Bank of Renovo, Renovo, Penn., and the Tucker Electrical Construction Company for the residence of A. G. Huntington at Bay Chester, N. Y.

The Consolidated Railway, Electric Light and Equipment Company have contracted for 1020-240 ampere-hour batteries for car lighting; the Herreshoff Manufacturing Company will install on

INDUSTRIAL

Mr. Herreshoff's private yacht a complete lighting and power battery for operating the search lights, ventilating fans and electric lights throughout the boat; a smaller battery will also be used in connection with an electric launch to be used as a tender for this yacht. The yacht Marjorie and the yacht Roxana will each have a battery of "Chloride Accumulators" installed for lighting purposes.

The North Shore Railroad Company is to have two batteries of "Chloride Accumulators," one to be located at San Anselmo, Cal., having a capacity of 846 kilowatts, the other located at Sausalito, Cal., having a capacity of 975 kilowatts, both of these batteries being used for line regulation. The Bay City Traction and Electric Company, Bay City, Mich., have contracted for a battery having a capacity of 288 kilowatts, this battery being used to regulate the fluctuations of the generator load. The Northwestern Fuel Company, Superior, Wis., have contracted for a battery having a capacity of 677 kilowatts, which is to be used entirely for the regulation of a motor load. The Bartlett illuminating Company will install for the use of the Saginaw Traction Company a battery having a capacity of 200 kilowatts, to be used in regulating the fluctuations on the latter company's railway circuit.

THE PELTON WATER WHEEL.

IT is gratifying to note the successful growth of a company that builds up on absolute merit. The Pelton Water Wheel Company were the inventors and first manufacturers of the "impulse" type of water wheels, and for years they worked and struggled with hydraulic problems until today the Pelton wheel is known and is in operation in every civilized country on the globe.

Through the agency of the Pelton wheel transmission plants are supplying millions of horsepower, driving electric cars, turning factory wheels, generating electricity for thousands of users. The invention of the Pelton wheel has been the means of harnessing brooks, streams and rivers which have for ages wasted their energies.

Some idea of the extent to which Pelton wheels have come into use may be obtained from the following list. There are now running something more than 11,000 Pelton wheels in various parts of the world in connection with electric transmission, mining, manufacturing and other industries aggregating in excess of 1,000,000 horsepower.

	Wheels.	Aggregate Horsepower.
In the United States—		
California, Oregon and Nevada.....	7,647	708,370
Washington, Idaho and Alaska.....	623	58,225
Utah, Colorado and Montana.....	176	24,970
Hawaii, New Mexico and Arizona.....	208	13,800
Middle, West and Atlantic States.....	146	5,670
In Foreign Countries—		
Mexico and Central America.....	636	152,905
Various South American States.....	371	24,660
Australia, Japan and India	484	40,250
East and West India Islands.....	243	30,250
British Columbia and Nova Scotia....	52	10,500
England and South Africa	77	12,220
Germany, France, Italy and Spain....	341	4,820
Norway, Sweden and Denmark.....	36	2,800
Total.....	11,040	1,089,440

In excess of 80 per cent. of efficiency is reported by the Gold Stream plant of the British Columbia Electric Railway at Victoria, B. C. So well satisfied is this company that they have given the Pelton Company another contract which is to increase the output of the Gold Stream plant. This additional installation will consist of a water wheel unit for direct connection to a 1000-kilowatt, 400 revolutions per minute, Canadian Westinghouse generator. This unit will consist of two wheels fitted with the latest type of Pelton buckets and needle nozzles with pilot control, and are to operate under an effective head of 600 feet. The wheels will be mounted one on each end of the main shaft, which will be carried on ring oiling ball and socket Pelton generator type bearings, and the wheels will be completely enclosed in sheet steel housings, mounted on heavy bed plates made also to carry the armature of the generators, thus making a complete iron mounted integral unit with the Westinghouse engine type generator. This unit will give considerable reserve capacity to this plant, which has been operating most successfully for a number of years past.

THE PARAFFINE PAINT COMPANY.

IN the annual number of this journal, published in January, appeared an article on the Los Angeles and Pacific Railway Company. This article was profusely illustrated and described very minutely the construction of big electric plants in the south. On page 22 the following statement was printed: "The roof itself is built of tongue and grooved plank and is covered with tar roofing paper to render it waterproof." While the writer of the article had no intention of doing so, he nevertheless slighted the Paraffine Paint Company, whose standard grade of P. & B. ready roofing cover completely all the buildings of the Los Angeles and Pacific Railway Company. Buildings of such construction could not afford to be roofed with a cheap paper roofing; in fact nothing short of the very best possible roofing made would be in keeping with the construction policy of this electric company. P. & B. ready roofing and Malthoid roofing, both of which are made by the Paraffine Paint Company, are recognized all over the civilized world as being the very best roofing it is possible to produce.

TRANSFORMER PRIMARY CUT-OUT.

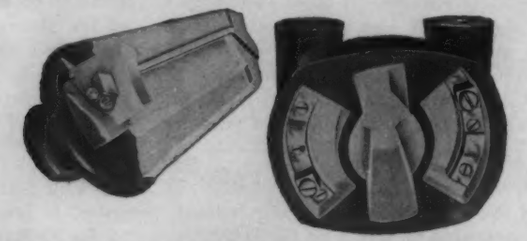
AN improved form of a transformer primary cut-out designed to protect the high tension side of transformers is being introduced by the Westinghouse Electric and Manufacturing Company. It is made entirely of porcelain, and its form is such that it has high insulating and arc breaking qualities.

The plug to which the fuse is attached projects between the terminals, the upper end of it rising well into the top of the block and interposing an effective barrier, and thus making it impossible to maintain an arc. The fuse is eleven inches in length, making a long break, and is so placed that the vapors of a discharge are blown down and out of the device and away from the terminals.

TRANSFORMER PRIMARY CUT-OUT, SHOWING INSULATOR TOP, HOLES FOR SCREWS AND OPENINGS FOR VIEWING FUSE

The line wire is carried directly to the top of the device and attached to it as to an ordinary insulator, which it thus displaces. To reach the terminal the wire must be bent around the edge of the block and is so supported to an angle between the terminal post and the porcelain case that it cannot be loosened by any swaying of the wind. The plug enters from the bottom. When it is raised into place a partial turn draws the knife blades on the plug into the jaws on the block, preventing the plug from dropping out or being blown out. All live parts are protected from the weather by the projecting edges of the block and by placing the terminals well above its lower surface, with no apertures in the side or top. A bend in the fuse wire brings it into plain view at all times, and it is thus possible to observe its condition without removing the plug, guarding against any liability of opening the circuit when there is a current upon the line. It is

fastened to the cross-arm or other support by two screws passing through porcelain tubes which form a portion of the block. It has a rated capacity of 2500 volts, 30 amperes. It is small, light, easy to install and to re-fuse,



TRANSFORMER PRIMARY CUT-OUT, SHOWING TERMINALS, PLUG WITH GROOVE FOR FUSE AND LOCKING DEVICE

and forms a very desirable addition to the assortment of high grade electrical line apparatus.

INDUSTRIAL

THE LUITWIELER PUMP.

CHAMPAIGN AND URBANA WATER COMPANY.

CHAMPAIGN, ILL., March 15, 1904.

Luitwieler Pumping Engine Company,
Los Angeles, Cal.:

DEAR SIRS—Replying to your letter of the 10th inst. asking our opinion of your pumps, will say that we bought our first pump of you about eighteen months ago, the second one about six months ago, and we are so pleased with them that we intend buying nothing else in this line in the future.

We have three other makes in service and are well qualified to judge which is the better pump. I consider your pump excels in the following particulars: Economy of operation, smoothness with which the water is delivered, there being no pulsation, no back lash in the rods, rendering the life of the rods at least four times as long as in other power heads we have in operation here.

Since we purchased our pumps the University of Illinois, located in this city, installed one of your pumps, and they are very much pleased with it. Smith Bros., of this city, just put in operation one of your pumps, it is of the latest pattern, and I want to say that it seems to me that you have about reached perfection in deep well pumping in this last machine.

I will be pleased to recommend your pump at all times.

Yours truly,
F. C. AMSBARY, Manager.

CEILINITE.

A NEW fireproofing material known as "Ceilinite" has been placed on the market by the H. W. Johns-Manville Company, 100 William Street, New York. It is designed especially for fireproofing the ceilings in electrical cars, for which purpose it is being used by the Pennsylvania Railroad Company and the Interborough Rapid Transit Company. "Ceilinite" may be used for lining partitions, ceilings, side walls, and at every point where a flexible fireproof barrier is required, as well as for various other purposes.

It is made from specially prepared asbestos in pieces one-eighth inch to three-eighths inch thick, thirty-six inches wide and about fifty feet long. Samples and prices may be obtained from the manufacturer's offices in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Pittsburg, Cleveland, New Orleans and London.

THE IMPROVED CINCINNATI AIR COMPRESSOR.

BULLETIN L-508 of The Laidlaw-Dunn-Gordon Company, of New York, bearing the foregoing title, is devoted to a new type of air compressor. The distinguishing feature of this machine is the novel manner in which the opening and closing of the exhaust ports are controlled. The exhaust opens through poppet valves, which is desirable, especially where the pressure pumped against is variable. The closing of the exhaust is determined by Corliss valves located in the passages between the cylinder and the poppet valves. These prevent all leakage of air back through the poppet valves while they are closing, and also, by providing a cushion of air under full pressure, allow them to seat easily and without noise. The opening and the closing of the admission are determined by the Corliss valves entirely. These and other novel features of the compressor are fully explained in this pamphlet, which is excellently printed upon the best coated paper and handsomely illustrated. It will be sent upon application to any one interested in air compressing machinery.

A NEW TRANSMISSION PLANT.

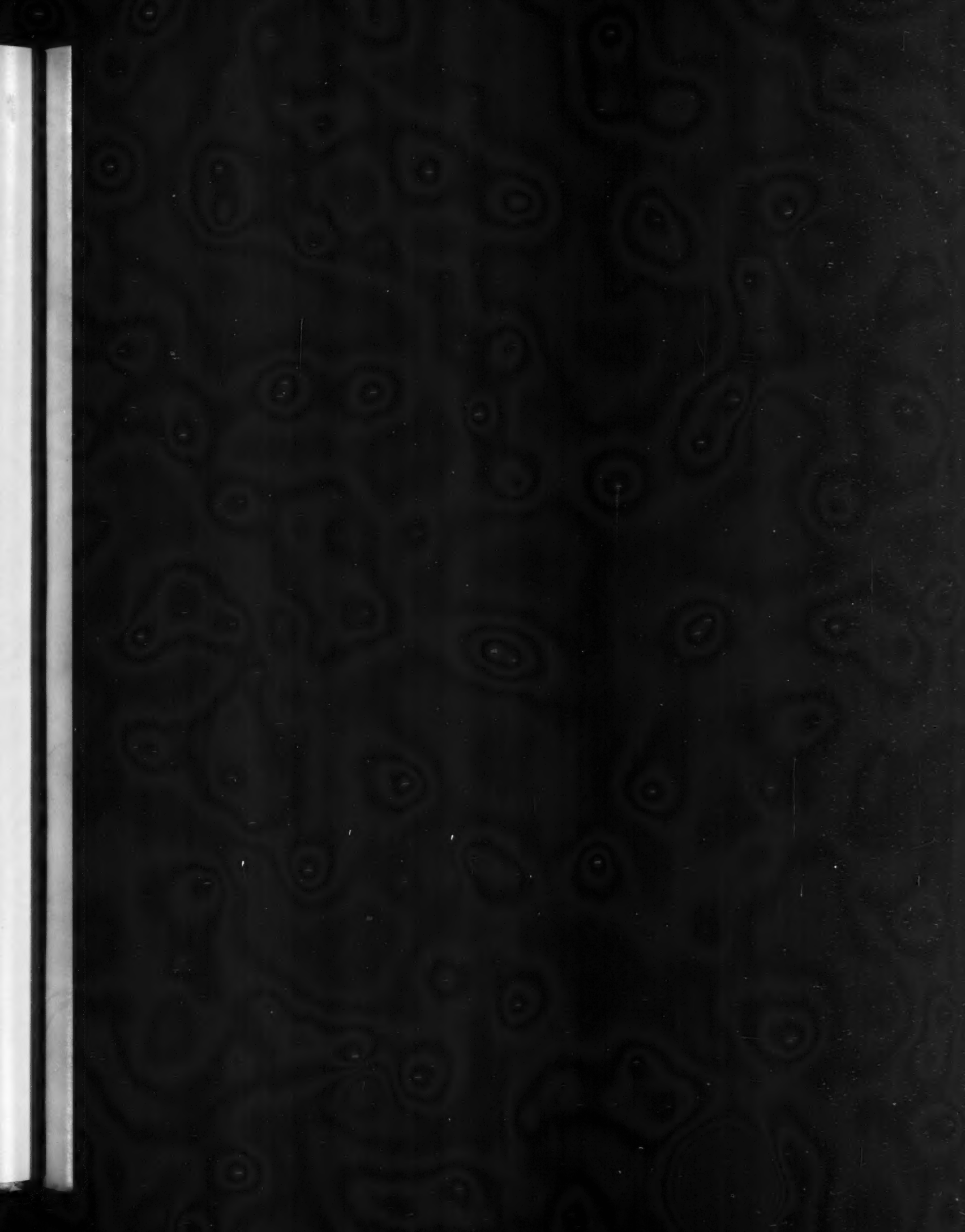
THE Rock Creek Power and Transmission Company, of Baker City, Or., are installing a plant near that place, consisting of two 400-kilowatt, three-phase, sixty-cycle, General Electric generators, directly coupled to 900-horsepower water wheels, running at 450 revolutions per minute. The latter were furnished by the Pelton Water Wheel Company, of San Francisco and operates under a head of 960 feet. Three 300-kilowatt, three-phase transformers raise the voltage to 22,500, at which pressure it is transmitted twenty-seven miles to Baker City and seventeen miles in another direction to adjoining mining properties. A mixed light and motor load has been secured up to capacity of the two generators. The latter will operate during the greater part of the time in parallel, but a single governor of the hydraulic pattern will control both units.

This plant is the most important of its kind in eastern Oregon, and is expected to be in commercial operation the latter part of this coming May.

PERSONAL.

Ray D. Lillibridge has returned to New York from his two months' trip to the West, having visited particularly the Pacific Coast and Colorado.

A. D. Schindler, formerly superintendent of the Fresno division of the Santa Fe, has been appointed assistant to President Foster of the California and Northwestern. The appointment will take effect April 1st.

A. M. Hunt, of the Engineering Offices, has returned from a month's tour of the Eastern States, where he found things comparatively quiet in electrical engineering enterprises. He visited the new electric generating plant of the Vancouver Power Company (Ltd.), near Vancouver, B. C., where the second 1500-kilowatt unit is being installed under the supervision of Wynn Meredith.

Philetus W. Gates and Henry W. Hoyt, respectively general superintendent and second vice-president of the Allis-Chalmers Company, are about to retire from active participation in the management of that company. Mr. Gates was president and Mr. Hoyt secretary and general manager of Gates' Iron Works for fifteen years prior to the incorporation of the Allis-Chalmers Company in 1901. They have been prominently connected with the manufacturing interests of Chicego and have taken an active part in all of the manufacturers' associations. The late P. W. Gates (father of Philetus W. Gates) was the pioneer manufacturer of Chicago and the region west of the Alleghanies, having established his business in 1842. From 1861 to 1871 the Eagle Works Manufacturing Company, of which he was president, employed about one thousand men, and in those days was a noteworthy industry. In 1871 the Eagle Works Manufacturing Company went out of existence, and from it were organized Gates' Iron Works and Fraser & Chalmers, each taking a portion of the business. Both of these companies in turn were taken over by the Allis-Chalmers Company in 1901. Messrs. Hoyt and Gates, after a well earned vacation spent in traveling, will re-engage in business in Chicago.